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DOE/DP/00539--051

DE84 013121

OFFSITE ENVIRONMENTAL MONITORING REPORT
Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1983

compiled by

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prepared for the
U. S. Department of Energy
under Interagency Agreement
Number DE-AI08-76DP00539

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PREFACE

The U.S. Atomic Energy Commission (AEC) used the Nevada Test Site (NTS) from January 1951 through January 19, 1976, for conducting nuclear weapons tests, nuclear rocket-engine development, nuclear medicine studies, and other nuclear and non-nuclear experiments. Beginning January 19, 1976, these activities became the responsibility of the newly formed U.S. Energy Research and Development Administration (ERDA). On October 1, 1977 the ERDA was merged with other energy-related agencies to form the U.S. Department of Energy (DOE). Atmospheric nuclear tests were conducted periodically from January 27, 1951, through October 30, 1958, after which a testing moratorium was in effect until September 1, 1961. Since September 1, 1961, all nuclear detonations have been conducted underground with the expectation of containment, except for four slightly above-ground or shallow underground tests of Operation Dominic II in 1962 and five nuclear earth-cratering experiments conducted under the Plowshare program between 1962 and 1968.

Prior to 1954, an offsite surveillance program was performed by the Los Alamos Scientific Laboratory and the U.S. Army. From 1954 through 1970 the U.S. Public Health Service (PHS), and from 1970 to the present the U.S. Environmental Protection Agency (EPA) have provided an Offsite Radiological Safety Program under an Interagency Agreement. The PHS or EPA has also provided offsite surveillance for U.S. nuclear explosive tests at places other than the NTS.

Since 1954, an objective of this surveillance program has been to measure levels and trends of radioactivity, if present, in the environment surrounding testing areas to ascertain whether the testing is in compliance with existing radiation protection standards. Offsite levels of radiation and radioactivity are assessed by sampling milk, water, and air; by deploying dosimeters; and by sampling food crops, soil, etc., as required. To implement protective actions, provide immediate radiation monitoring, and obtain environmental samples rapidly after any release of radioactivity, personnel with mobile monitoring equipment are placed in areas downwind from the test site prior to each test. Since 1962, aircraft have also been deployed to rapidly monitor and sample releases of radioactivity during nuclear tests. Monitoring data obtained by the aircraft crew immediately after a test are used to position mobile radiation monitoring personnel on the ground. Data from airborne sampling are used to quantify the amounts, diffusion, and transport of the radionuclides released.

Beginning with Operation Upshot-Knothole in 1953, a report was published by the PHS summarizing the surveillance data for each test series. In 1959 for reactor tests, and in 1962 for weapons and Plowshare tests, such data were published for those tests that released radioactivity detectable off the NTS.

The reporting was changed again in 1964 to semi-annual publication of data for each 6-month period which also included the data from the individual reports.

In 1971, the AEC implemented a requirement, now referred to as the DOE Order 5484.1, that each contractor or agency involved in major nuclear activities provide a comprehensive annual radiological monitoring report. This is the twelth annual report in this series; it summarizes the activities of the EPA during CY 1983.

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ABBREVIATIONS, SYMBOLS AND CONVERSIONS

a	annum (year)
ASN	Air Surveillance Network
CG	Concentration Guide
Ci	Curie
CP-1	Control Point One
CY	Calendar Year
d	day
DOE	U.S. Department of Energy
DOE/NV	Department of Energy, Nevada Operations Office
EMSL-LV	Environmental Monitoring Systems Laboratory, Las Vegas
EPA	U.S. Environmental Protection Agency
eV	electron volt
g	gram
GZ	Ground Zero
h	hour
HTO	tritiated water
L	liter
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	Minimum Detectable Concentration
MSL	Mean Sea Level
MSN	Milk Surveillance Network
NGTSN	Noble Gas and Tritium Surveillance Network
NTS	Nevada Test Site
Pa	Pascal - unit of pressure
R	Roentgen
rad	unit of absorbed dose, 100 ergs/g
rem	the rad adjusted for biological effect
TLD	thermoluminescent dosimeter

PREFIXES

a atto = 10^{-18}
f femto = 10^{-15}
p pico = 10^{-12}
n nano = 10^{-9}
μ micro = 10^{-6}
m milli = 10^{-3}
k kilo = 10^{3}
M Mega = 10^{6}

CONVERSIONS

Multiply	By	To Obtain
Concentration Guides		
μCi/mL	10^{9}	pCi/L
μCi/mL	10^{12}	pCi/m^3
SI Units		
rad	10^{-2}	Gray (Gy = 1 Joule/kg)
rem	10^{-2}	Sievert (Sv)
pCi	0.037	Becquerel

SECTION 1

SUMMARY

PURPOSE

It is U.S. Environmental Protection Agency policy to protect the general public and the environment from pollution caused by human activities. This includes radioactive contamination of the biosphere and concomitant radiation exposure of the population. To this end and in concordance with U.S. Department of Energy policy of keeping radiation exposure of the general public as low as reasonably achievable, the EMSL-LV conducts an Offsite Radiological Safety Program centered on the DOE's Nevada Test Site. This program is conducted under an Interagency Agreement between EPA and DOE.

A principal activity of the Offsite Radiological Safety Program is routine environmental monitoring for radioactive materials in various media and for radiation in areas which may be affected by nuclear tests. It is conducted to document compliance with standards, to identify trends, and to provide information to the public. This report summarizes these activities for CY 1983.

Locations

Most of the radiological safety effort is applied in the areas around the Nevada Test Site in south-central Nevada. The principal activity at the NTS is testing of nuclear devices, though other related projects are also conducted. This portion of Nevada is sparsely settled, 0.5 person/km^2, and has a continental arid climate. The largest town in the near offsite area is Beatty, located about 65 km west of the NTS with a population of about 800.

Underground tests have been conducted in several other States for various purposes. At these sites in Alaska, Colorado, New Mexico and Mississippi, a long-term hydrological monitoring program (LTHMP) is conducted to detect any possible contamination of potable water and aquifers near these sites.

Pathways Monitoring

The pathways leading to human exposure to radionuclides, namely air, water and food, are monitored by networks of sampling stations. The networks are designed not only to detect radiation from DOE/NV nuclear test areas but also to detect increases in population exposure from other sources.

In 1983 the air surveillance network (ASN) consisted of 29 continuously operating stations surrounding the NTS and 85 standby stations (operated 1 or 2 weeks each quarter) in all States west of the Mississippi. Other than naturally occurring beryllium-7, the only activity detected by this network was plutonium-239 from worldwide fallout.

The noble gas and tritium sampling network (NGTSN) consisted of 16 stations offsite (off the NTS and exclusion areas) in 1983. No NTS-related radioactivity was detected at any offsite station. Tritium concentration in air remained below MDC levels and krypton-85 concentration continued the upward trend which started in 1960, reflecting the worldwide increase in the use of nuclear technology.

The long-term hydrological monitoring of wells and surface waters near sites of nuclear tests showed only background tritium and other radionuclide concentrations except for those wells that enter the test cavity or those that were previously spiked with radionuclides for hydrological tests.

The milk surveillance network (MSN) consisted of 28 sampling locations within 300 km of the NTS and about 86 standby locations in the Western U.S. The tritium concentration in milk was at background levels, and strontium-90 from worldwide fallout continued the slow downward trend observed in recent years.

Other foods analyzed have been mainly meat from domestic or game animals and garden vegetables. The radionuclide most frequently found in the edible portion of the sampled animals is cesium-137. Its concentration has been low since 1968. Meat from deer that reside on the NTS has not had markedly higher concentrations of radionuclides than meat from deer that reside in other areas of Nevada.

External Exposure

External exposure is monitored by a network of TLD's at 86 locations surrounding the NTS and by TLD's worn by 46 offsite residents. In a few cases, small exposures of a few mrem above the average for the person or location were measured. Except for several occupational exposures, all such net exposures were very low and were not related to NTS activities. The range of exposures measured, varying with altitude and soil constituents, is similar to the range of such exposures found in other areas of the U.S.

Internal Exposure

Internal exposure is assessed by whole-body counting supplemented by phoswich detectors to measure lung burdens of radioactivity. In 1983, counts were made on 154 offsite residents, and on 166 EPA and EG&G, 2 DRI, 1 REECo, and 3 WSI employees. Natural potassium-40 was found as expected, but no nuclear test related radioactivity was detected. In addition, physical examinations of the offsite residents revealed only a normally healthy population consonant with the age and sex distribution of that population.

Community Monitoring Stations

The 15 Community Monitoring Stations became operational in 1982. Each station is operated by a resident of the community who is trained to collect samples and interpret some of the data. Each station is an integral part of the ASN, NGTSN and TLD networks and is also equipped with a pressurized ion chamber system and recording barograph. Samples and data from the stations are analyzed by EMSL-LV and are also interpreted and reported by the Desert Research Institute, University of Nevada. Data from these stations are reported herein as part of the networks in which they participate.

Dose Assessment

Doses were calculated for an average adult living in Nevada based on the Kr-85, Sr-90, Cs-137 and Pu-239 detected by the monitoring networks. Using conservative assumptions, the estimated dose would have been less than 0.2 mrem per year, a small fraction of the variation of 10 mrem per year due to the natural radionuclide content of the body. Since no radioactivity originating on the NTS was detectable offsite, no dose assessment related to NTS activities could be made. However, atmospheric dispersion calculations, based on known emissions from the NTS, indicate that the population dose within 80 km of CP-1 was about 5×10^{-5} man-rem for 1983.

SECTION 2

INTRODUCTION

The EMSL-LV operates an Offsite Radiological Safety Program around the NTS and other sites as requested by the Department of Energy (DOE) under an Interagency Agreement between DOE and EPA. This report, prepared in accordance with the guidelines in DOE/EP-0023 (DOE 1981a), covers the program activities for calendar year 1983. It contains descriptions of pertinent features of the NTS and its environs, summaries of the EMSL-LV dosimetry and sampling methods, analytical procedures, and the analytical results from environmental measurements. Where applicable, dosimetry and sampling data are compared to appropriate guides for external and internal exposures of humans to ionizing radiation.

SECTION 3

DESCRIPTION OF THE NEVADA TEST SITE

Historically, the major programs conducted at the NTS have been nuclear weapons development, proof-testing and weapons safety and effects, testing peaceful uses of nuclear explosives (Plowshare Program), reactor engine development for nuclear rocket and ramjet applications (Projects Pluto and Rover), high-energy nuclear physics research, seismic studies (Vela Uniform), and studies of high-level waste storage. During 1983, nuclear weapons development, proof-testing and weapons safety, nuclear physics programs, and studies of high-level waste storage were continued at the NTS. Project Pluto was discontinued in 1964; Project Rover was terminated in January 1973; Plowshare tests were terminated in 1970; Vela Uniform studies ceased in 1973. All nuclear weapons tests since 1962 have been conducted underground. More detail and pertinent maps for the portions of this section are included in Appendix A. Only selected information is presented in this Section.

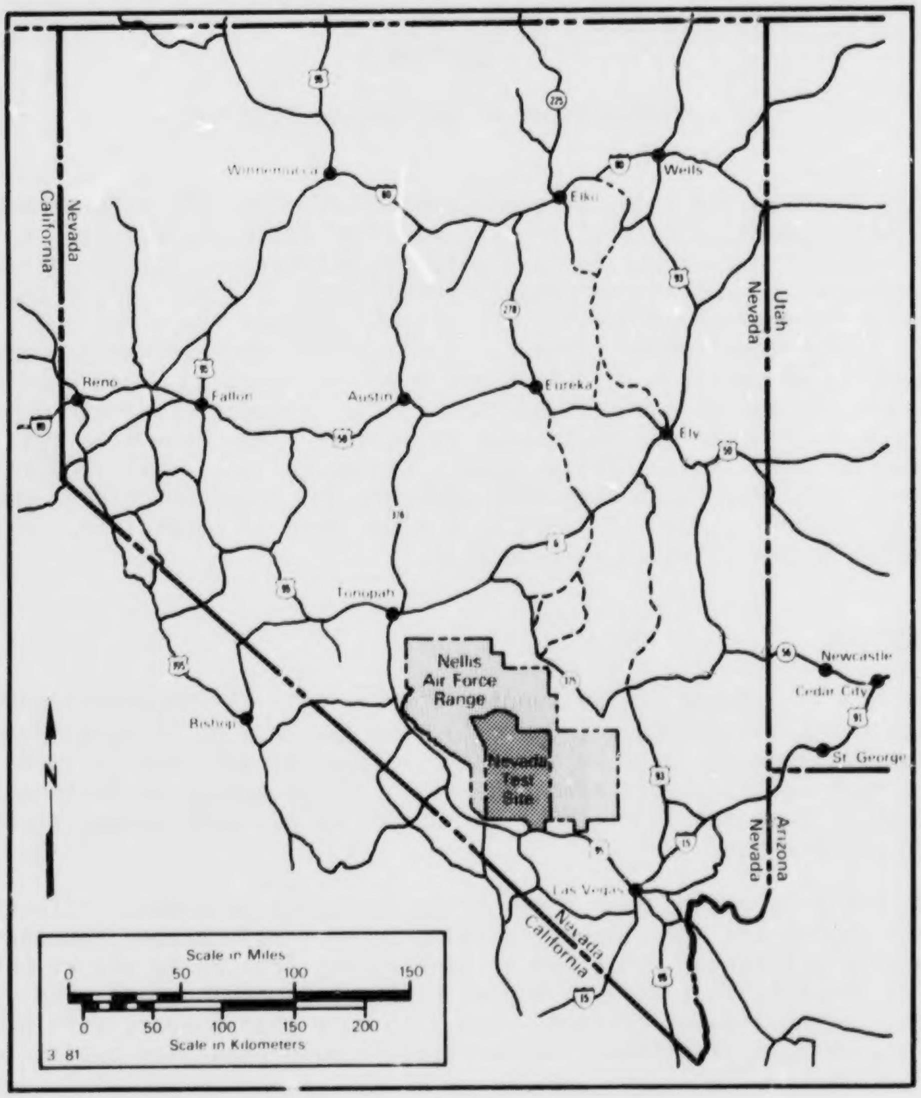
SITE LOCATION

The NTS is located in Nye County, Nevada, with its southeast corner about 90 km northwest of Las Vegas (Figure 1). It has an area of about 3,500 square km and varies from 40 to 56 km in width (east-west) and from 64 to 88 km in length (north-south). This area consists of large basins or flats about 900 to 1,200 m above mean sea level (MSL) surrounded by mountain ranges rising 1,800 to 2,300 m above MSL.

The NTS is surrounded on three sides by exclusion areas, collectively named the Nellis Air Force Range, which provide a buffer zone between the test areas and public lands. This buffer zone varies from 24 to 104 km between the test area and land that is open to the public. Depending upon wind speed and direction at the time of testing, from 2 to more than 6 hours will elapse before any release of airborne radioactivity could pass over public lands.

CLIMATE

The climate of the NTS and surrounding area is variable, due to its variations in altitude and its rugged terrain. Generally, the climate is referred to as continental arid. Throughout the year, there is insufficient precipitation to support the growth of common food crops without irrigation.


Winnemucca
Wells
Elko
Nevada
California
Utah
Nevada
Reno
Fallon
Austin
Eureka
Ely
Tonopah
Nellis Air Force Range
Nevada Test Site
Newcastle
Cedar City
St. George
Bishop
N
Las Vegas
Arizona
Nevada
Nevada
California
Scale in Miles
0
50
100
150
0
50
100
150
200
Scale in Kilometers
3 81
95
225
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93
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50
376
6
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395
56
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93
15
95
15
95

Figure 1. Location of the Nevada Test Site (NTS).

As Houghton et al. (1975) point out, 90 percent of Nevada's population lives in areas with less than 25 cm of rainfall per year or in areas that would be classified as mid-latitude steppe to low-latitude desert regions.

The wind direction, as measured on a 30-m tower at an observation station about 9 km NNW of Yucca Lake near CP-1, is predominantly northerly except during May through August when winds from the south-southwest predominate (Quiring 1968). Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours of most months. During the winter months southerly winds have only a slight edge over northerly winds for a few hours during the warmest part of the day. These wind patterns are often quite different at other locations on the NTS because of local terrain effects and differences in elevation.

GEOLOGY AND HYDROLOGY

Geological and hydrological studies of the NTS have been in progress by the U.S. Geological Survey and various other organizations since 1956. Because of this continuing effort, including subsurface studies of numerous boreholes, the surface and underground geological and hydrological characteristics for much of the NTS are known in considerable detail (see Figure A-1). This is particularly true for those areas in which underground experiments are conducted. A comprehensive summary of the geology and hydrology of the NTS by Winograd and Thordarson was published in 1975.

The aquifers underlying the NTS vary in depths from about 200 m beneath the surface of valleys in the southeastern part of the site to more than 500 m beneath the surface of highlands to the north. Although much of the valley fill is saturated, downward movement of water is retarded by various tuffs and is extremely slow. The primary aquifer in these formations consists of Paleozoic carbonates that underlie the more recent tuffs and alluviums.

LAND USE OF NTS ENVIRONS

Industry within the immediate off-NTS area includes approximately 40 active mines and mills, oil fields in the Railroad Valley area, and several industrial plants in Henderson, Nevada. The number of employees for these operations may vary from one person at several of the small mines to several hundred workers for the oil fields north of the NTS and the industrial plants in Henderson. Most of the individual mining operations involve less than 10 workers per mine; however, a few operations employ 100 to 250 workers.

The major body of water close to the NTS is Lake Mead (120 km southeast, Figure A-2), a manmade lake supplied by water from the Colorado River. Lake Mead supplies about 60 percent of the water used for domestic, recreational, and industrial purposes in the Las Vegas Valley. Some Lake Mead water is used in Arizona, southern California, and Mexico. Smaller reservoirs and lakes located in the area are used primarily for irrigation, for watering livestock, and for wildlife refuges.

Dairy farming is not extensive within 300 km of the NTS. A survey of milk cows during the summer of 1983 showed 78,000 dairy cows, 757 family milk cows and 847 family milk goats in the area (Figures A-4 and A-5). The family cows and goats are distributed in all directions around the NTS, whereas most dairy cows are located to the southeast (Moapa River, Nevada; Virgin River Valley, Nevada; and Las Vegas, Nevada), northeast (Lund), and southwest (near Barstow, California).

Grazing is the most common land use within 300 km of the site. Approximately 650,000 cattle and 110,000 sheep are distributed within the area as shown in Appendix Figures A-6 and A-7, respectively. The estimates are based on information supplied by the California livestock statistics report, from 1983 agricultural statistics supplied by the Nevada Department of Agriculture and from 1982 census information supplied by the Utah Department of Agriculture.

POPULATION DISTRIBUTION

Excluding Clark County, the major population center (approximately 462,000 in 1980), the population density within a 150 km radius of CP-1 on the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for all of Nevada in 1980 was 2.8 persons per square kilometer.

The offsite area within 80 km of the NTS (the area in which the dose commitment must be determined for the purpose of this report) is predominantly rural, Figure A-3. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of about 3,900, is located about 72 km south-southwest of the NTS CP-1. The Amargosa Farm Area, which has a population of about 1,500, is located about 50 km southwest of CP-1. The largest town in the near-offsite area is Beatty, which has a population of about 800 and is located approximately 65 km to the west of CP-1.

AIRBORNE RELEASES OF RADIOACTIVITY AT THE NTS DURING 1983

All nuclear detonations during 1983 were conducted underground and were contained, although occasional releases of low-level radioactivity occurred during re-entry drilling. Table 1 shows the total quantities of radionuclides released to the atmosphere, as reported by the DOE Nevada Operations Office (1984). Because these releases occurred throughout the year, and because of the distance from the points of releases to the nearest sampling station, none of the radioactive nuclides listed in this table were detected offsite.

TABLE 1. TOTAL AIRBORNE RADIONUCLIDE EMISSIONS AT THE NTS DURING 1983

Radionuclide	Half-Life (days)	Quantity Released (Ci)
Tritium	4,500	98.2
Iodine-131	8.04	1×10^{-5}
Iodine-135	0.27	3×10^{-5}
Xenon-133	5.29	26.6
Xenon-133m	2.33	1.5
Xenon-135	0.38	28.9

SECTION 4

QUALITY ASSURANCE

GOALS

The goals of the EMSL-LV quality assurance program are to assure the collection and analysis of environmental samples with the highest degree of accuracy and precision obtainable with state-of-the-art instrumentation and to achieve the best possible completeness and comparability given the extent and type of networks from which samples are collected. To meet these goals, it is necessary to devote strict attention to both the sample collection and sample analysis procedures.

SAMPLE COLLECTION

The collection of samples is governed by a detailed set of Standard Operating Procedures (SOP's). These SOP's prescribe the frequency and method of collection, the type of collection media, sample containment and transport, sample preservation, sample identification and labeling, and operating parameters for the instrumentation. Sample control is an important segment of these activities as it enables tracking from collection to analysis for each sample and governs the selection of duplicate samples for analysis and the samples chosen for replicate analysis.

These procedures provide assurance that sample collection, labeling and handling are standardized to minimize sample variability due to inconsistency among these variables.

SAMPLE ANALYSIS

All of the networks operated by the EMSL-LV have individual Quality Assurance Project Plans that assure the results of analysis will be of known quality and will be comparable to results obtained elsewhere with equivalent procedures. These Plans are summarized in the following sections.

External QA

External QA provides the data from which the accuracy of analysis (a combination of bias and precision) can be determined. Bias is assessed from the results obtained on intercomparison study samples and on samples "spiked" with known amounts of radionuclides. The Offsite Radiological Safety Program participates in Intercomparison Study Programs that include environmental sample analysis, TLD dosimetry, and whole-body counting. Also, samples unknown to the analyst are spiked by adding known amounts of radionuclides and entered into the normal chain of analysis.

Data for precision are collected from duplicate and replicate analyses. At least 10 percent of all samples are collected in duplicate. When analyzed, the data indicate the precision of both sample collection and analysis. Replicate counting of at least 10 percent of all samples yield data from which the precision of counting can be determined.

If the bias and precision data are of sufficient quality (i.e., normalized deviation in Table C-3 is less than 3), then comparability, i.e., comparison of the data with those of other analytical laboratories, can be assessed with confidence. The results of external QA procedures are shown in Appendix C.

Internal QA

Internal QA consists of those procedures used by the analyst to assure proper sample preparation and analysis. The principal procedures used are the following:

- Instrument background counts
- Blank and reagent analyses
- Instrument calibration with known nuclides
- Laboratory control standards analysis
- Performance check-source analysis
- Maintenance of control charts for background and check-source data
- Scheduled instrument maintenance

These procedures ensure that the instrumentation is not contaminated, that calibration is correct, and that standards carried through the total analytical procedure are accurately analyzed.

VALIDATION

After the results are produced, supervisory personnel examine the data to determine whether or not the analysis is valid. This includes checking all procedures from sample receipt to analytical result with particular attention to the internal QA data and comparison of the results with previous data from similar samples at the same location.

Any variant result or failure to follow internal QA procedures during sample analysis will trigger an internal audit of the analytical procedures and/or a re-analysis of the sample or its duplicate.

AUDITS

All analytical data are reviewed by personnel of the Dose Assessment Branch for completeness and consistency. Investigations are conducted to resolve any inconsistencies and corrective actions are taken if necessary. SOP's and QA project plans are revised as needed following review of procedures and methodology. The EMSL-LV QA Officer audits the operations periodically.

SECTION 5

RADIOLOGICAL SAFETY ACTIVITIES

The radiological safety activities of the EMSL-LV are divided into two major areas: special test support and routine environmental surveillance. Both of these activities are designed to detect any increase in environmental radiation which might cause exposure to individuals or population groups so that protective actions may be taken, to the extent feasible. These activities are described in the following portions of this report.

SPECIAL TEST SUPPORT

Before each nuclear test, mobile monitoring personnel are positioned in the offsite areas most likely to be affected should a release of radioactive material occur. They ascertain the locations of residents, work crews and animal herds and obtain information relative to controllability of residents in communities and remote areas. These monitors, equipped with radiation survey instruments, gamma exposure-rate recorders, thermoluminescent dosimeters (TLD's), portable air samplers, and supplies for collecting environmental samples, are prepared to conduct a monitoring program as directed from the NTS Control Point (CP-1) via two-way radio communications.

For those tests which might cause ground motion detectable offsite, EPA monitors are stationed at locations where hazardous situations might ensue. At these locations, e.g., mines and specific buildings, occupants are notified of potential hazard so they can take precautionary measures.

Professional EPA personnel serve as members of the Test Controller's Advisory Panel to provide advice on possible public and environmental impact of each test and feasible protective actions in case accidental releases of radioactivity should occur.

An EG&G cloud sampling and tracking aircraft is flown over the NTS to obtain samples, assess total cloud volume, and provide long-range tracking in the event of a release of airborne radioactivity. A second EG&G aircraft is flown to gather meteorological data and to perform cloud tracking. Information from these aircraft can be used in positioning the radiation monitors.

Previous to this year, emergency situations which arose as a result of accidental leakage from any NTS nuclear tests, e.g., establishing road blocks, advising residents to remain indoors, substituting feed for dairy herds, etc., were handled informally with the cooperation of local authorities. These procedures are now being formalized. During 1983 an Emergency Response Plan was formulated, among EPA, DOE, and Lincoln County Officials, which will become a portion of the County Emergency Plan. Under this plan, the County will institute emergency response measures with the advice of EPA and DOE personnel. Similar plans will be formulated with the counties of Nye, Clark, White Pine, and Esmeralda in the near future.

During CY 1983 none of the tests conducted at the NTS released radioactivity that was detected offsite.

PATHWAYS MONITORING

The offsite radiation monitoring program includes pathways monitoring consisting of air, water and milk surveillance networks surrounding the NTS and a limited animal sampling project. These are explained in detail below.

Air Surveillance Network (ASN)

Network Design--

The ASN monitors an important route of human exposure to radionuclides: inhalation of airborne materials. Not only the concentration but also the source must be determined if appropriate corrective actions are to be taken. The ASN is designed to cover the areas within 200 km of the NTS with some concentration of stations in the prevailing downwind direction (Figure 2). The coverage is constrained to those locations having avvailable electrical power and a resident willing to operate the equipment. This continuously operating network is reinforced by a standby network which covers the contiguous States west of the Mississippi River, Figure 3.

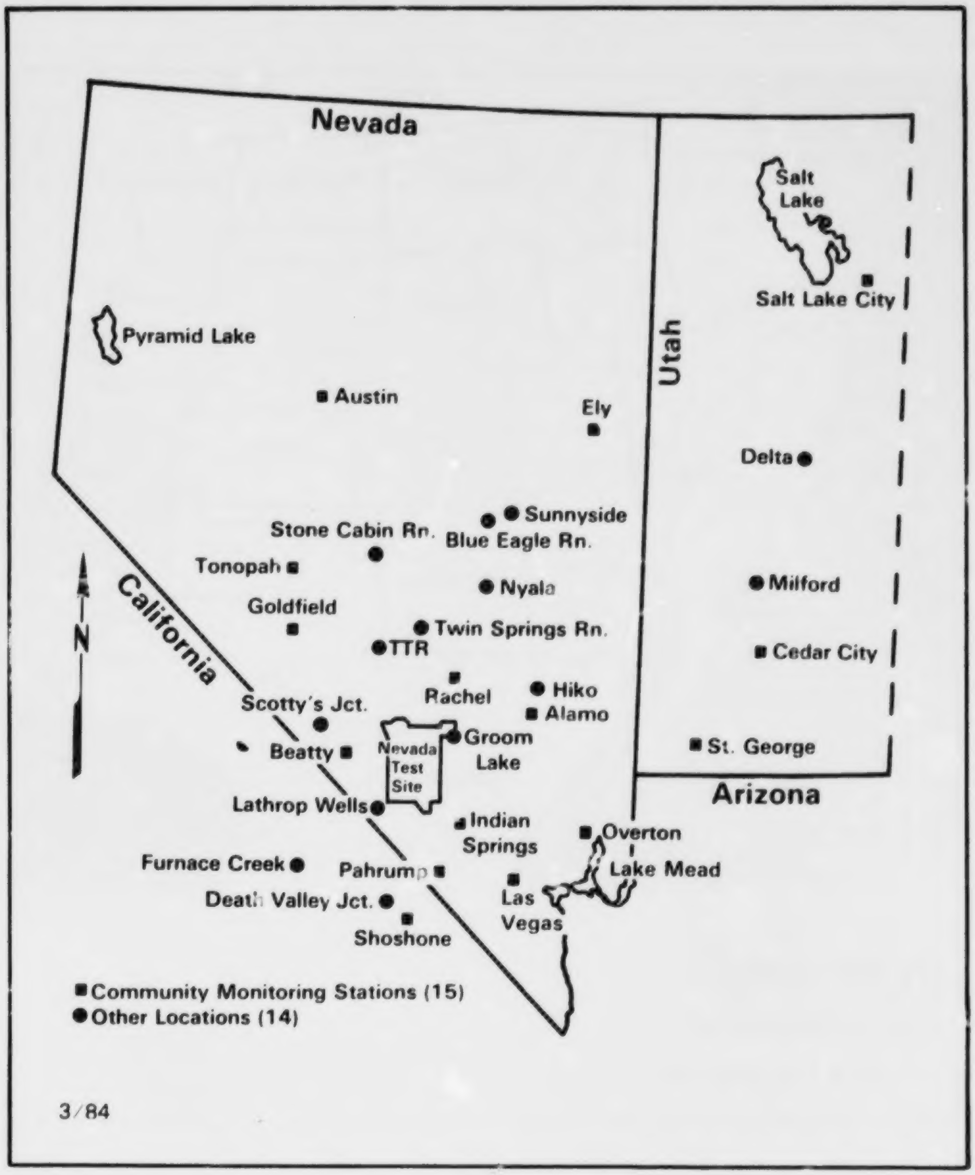
Methods--

During 1983 the ASN consisted of 29 continuously operating sampling stations and 85 standby stations. The air sampler at each station was equipped to collect both particulate radionuclides and reactive gases.

Samples of airborne particulates were collected at each active station on 5-cm diameter glass-fiber filters at a flow rate of about 81 m^3 per day. Filters were changed after sampler operation periods of 2 or 3 days (160 to 240 m^3). Activated charcoal cartridges placed directly behind the filters to collect gaseous radioiodine were changed at the same time as the filters. The standby network was activated for 1 to 2 weeks per quarter. The samplers are identical to those used in the ASN and are operated by State and municipal health department personnel or by local residents. All air filters and charcoal cartridges were analyzed by the EMSL-LV.

Results--

Throughout the network, beryllium-7 was the only nuclide detected by gamma spectroscopy. The principal means of beryllium-7 production is from spallation of oxygen-16 and nitrogen-14 in the atmosphere by cosmic rays. Appendix Tables



Nevada
Utah
Arizona
California
N
Salt Lake
Salt Lake City
Pyramid Lake
Austin
Ely
Delta
Sunnyside
Stone Cabin Rn.
Blue Eagle Rn.
Tonopah
Nyala
Milford
Goldfield
Twin Springs Rn.
TTR
Cedar City
Rachel
Hiko
Alamo
Scotty's Jct.
Groom Lake
Beatty
Nevada Test Site
St. George
Lathrop Wells
Indian Springs
Overton
Furnace Creek
Pahrump
Lake Mead
Las Vegas
Death Valley Jct.
Shoshone
■ Community Monitoring Stations (15)
● Other Locations (14)
3/84

Figure 2. Air Surveillance Network stations (1983).

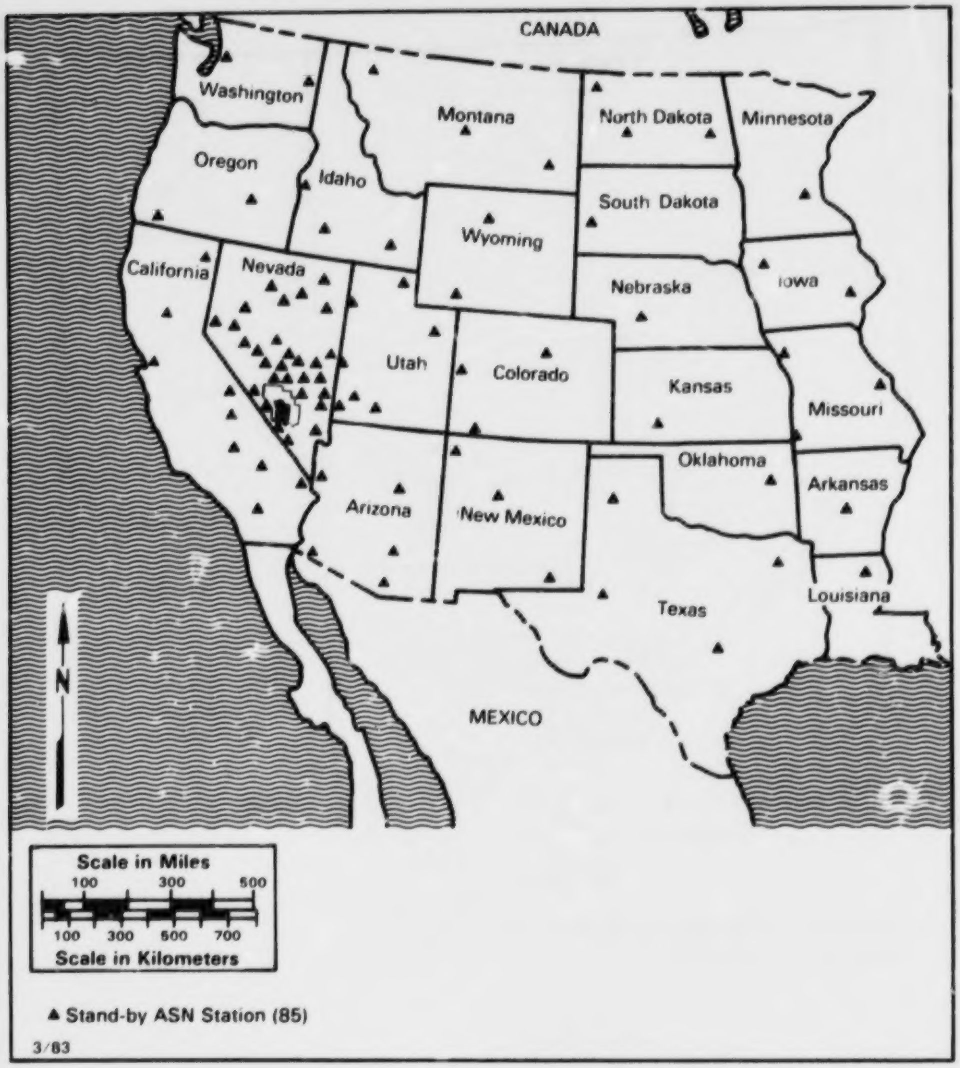

CANADA
Washington
Montana
North Dakota
Minnesota
Oregon
Idaho
South Dakota
Wyoming
California
Nevada
Nebraska
Iowa
Utah
Colorado
Kansas
Missouri
Oklahoma
Arkansas
Arizona
New Mexico
Texas
Louisiana
MEXICO
N
Scale in Miles
100
300
500
100
300
500
700
Scale in Kilometers
▲ Stand-by ASN Station (85)
3/83

Figure 3. Standby Air Surveillance Network stations (1983).

E-1 and E-2 summarize the data from the ASN samples. All time-weighted averages (Avg in the tables) are less than 1 percent of the Concentration Guide (Appendix D) for exposure to the general public, however, these guides do not apply to naturally-occurring radionuclides.

During 1983, no airborne radioactivity related to nuclear testing at the NTS was detected on any sample from the ASN.

A plot of the logarithm of the individual concentrations of beryllium-7 for all stations during the year versus probits indicates that the air data are approximately lognormally distributed. The distribution for the individual nuclide that was detected indicated that there was a single source, assumed to be worldwide, because all stations were affected similarly.

Two special studies are performed on the samples from the ASN: a gross beta analysis of the filters from 5 stations, and plutonium-238 and plutonium-239 analysis of composited filters from 17 States.

The gross beta analysis is used to detect trends in atmospheric radioactivity more quickly than is possible with gamma spectrometry. For this study, three stations north and east of the NTS, and two stations south and west of the NTS are used. The three filters per week from each station are analyzed for gross beta activity after a 7-day delay to decrease the contribution from thoron daughter activity. The data suggest little significant difference among stations and indicate a relatively stable concentration compared to previous years (Figure 4). The maximum concentration measured was 0.08 pCi/m^3, the minimum was <0.006 pCi/m^3, and the arithmetic average was 0.008 pCi/m^3. A summary of the data is shown in Appendix Table E-4. The gross beta analysis was reinstated in July 1981. Fallout from the Chinese atmospheric test in 1980 was still detectable at that time, but it appears to have decreased significantly.

The plutonium study uses the filters from 32 standby ASN stations distant from the NTS, and from three ASN stations near the NTS. The filters from two standby stations in each State (operated 1 or 2 weeks per quarter) are composited quarterly, and those from the ASN stations are composited monthly. The composites are analyzed radiochemically as indicated in Appendix B.

The available data for plutonium-238 and -239 concentration in air are shown in the Appendix (Table E-5). All results were less than the MDC except for the Missouri composite for May 1983. The actual net activity is displayed in the Appendix table. The percent of the concentration guide that is shown is calculated for the sum of the plutonium concentrations, assuming the concentration measured was the annual average for that sampling location.

Noble Gas and Tritium Surveillance Network

Network Design--

There are several sources for the radionuclides monitored by this network. Noble gases are emitted from nuclear power plants, propulsion reactors, reprocessing facilities and nuclear explosions. Tritium is emitted from the same

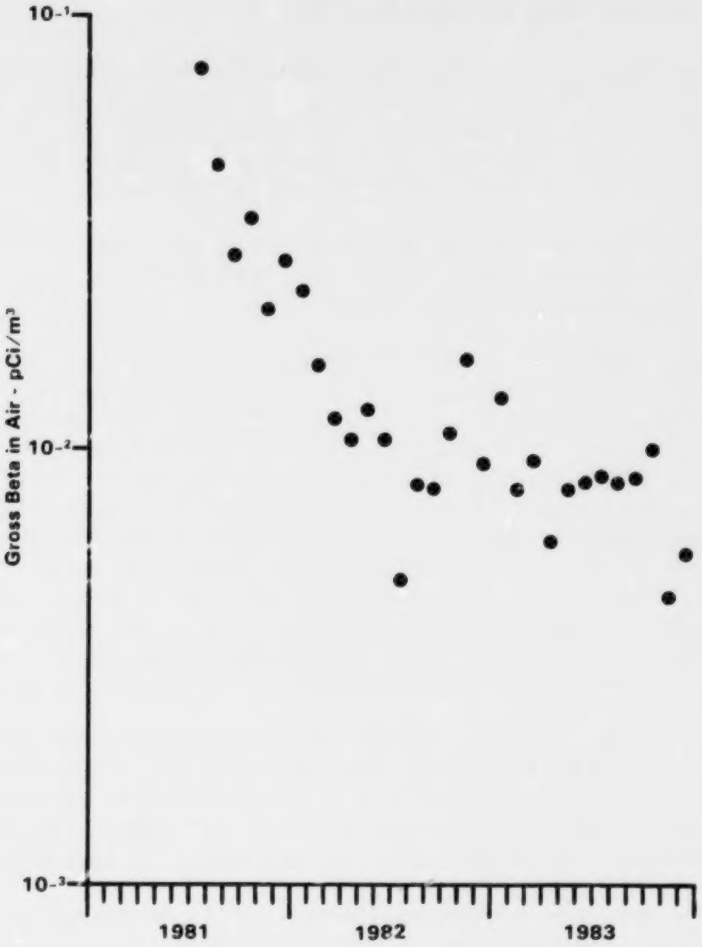


Figure 4. Monthly average gross beta in air samples, 1981-83.

sources and is also produced naturally. The monitoring network will be affected by all these sources, but must be able to detect NTS emissions. For this purpose some of the samplers are located close to the NTS and particularly in drainage-wind channels leading from the test areas. In 1983 this network consisted of 16 stations as shown in Figure 5.

Methodology--

Samples of air are collected by either of two methods; by directly compressing or by liquefying air using cryogenic techniques. Either type of equipment continuously samples air over a 7-day period and stores approximately 1 cubic meter of air in pressure tanks. The tanks are exchanged weekly and returned to the EMSL-LV where their contents are analyzed. Analysis starts by condensing the samples at liquid nitrogen temperature and using gas chromatography to separate the gases. The separate fractions of radioxenon and radiokrypton are dissolved in scintillation cocktails and counted in a liquid scintillation counter (see Appendix B).

For tritium sampling, a molecular sieve column is used to collect water from air. A prefilter is used to remove particles before air passes through the molecular sieve column. Up to 10 cubic meters of air are passed through each column over a 7-day sampling period. Water adsorbed on the molecular sieve is recovered, and the concentration of tritium in the water (HTO) is determined by liquid scintillation counting techniques (see Appendix B).

Results--

All results are shown in Appendix Table E-3 as the maximum, minimum and average concentration for each station. These data indicate that no radioactivity from NTS tests was detected offsite by the Noble Gas and Tritium Surveillance Network during 1983. The average concentrations of krypton-85 at all network stations ranged from 23 to 27 pCi/m^3 (as shown in Figure 6).

The concentrations of krypton-85 within the whole network appeared to have a skewed distribution. The lognormal distribution had a geometric mean of 24 pCi/m^3 and a geometric standard deviation of 1.15.

As shown in Table 2 and Figure 7, the average concentration of krypton-85 for the whole network has gradually increased since sampling began in 1972. This increase, observed at all stations, reflects the worldwide increase in ambient concentrations resulting from the increased use of nuclear technology. The increase in ambient krypton-85 concentration was projected by Bernhardt, et al., (1973). However, the measured network average in 1983 is only about 16% percent of the 160 pCi/m^3 predicted by Bernhardt. Since nuclear fuel reprocessing is the primary source of krypton-85, the decision of the United States to defer fuel reprocessing may be one reason why krypton-85 levels have not increased as fast as predicted.

Using published data for krypton-85 concentration in air (NCRP 1975) and the data from our network (Table 2), the change over time was plotted as shown in Figure 7. Linear correlation analysis indicates that the krypton concentration/time relation is pCi/m^3 = 5.7 + 0.82t where t is number of years after 1960. The correlation coefficient, R, is 0.98.

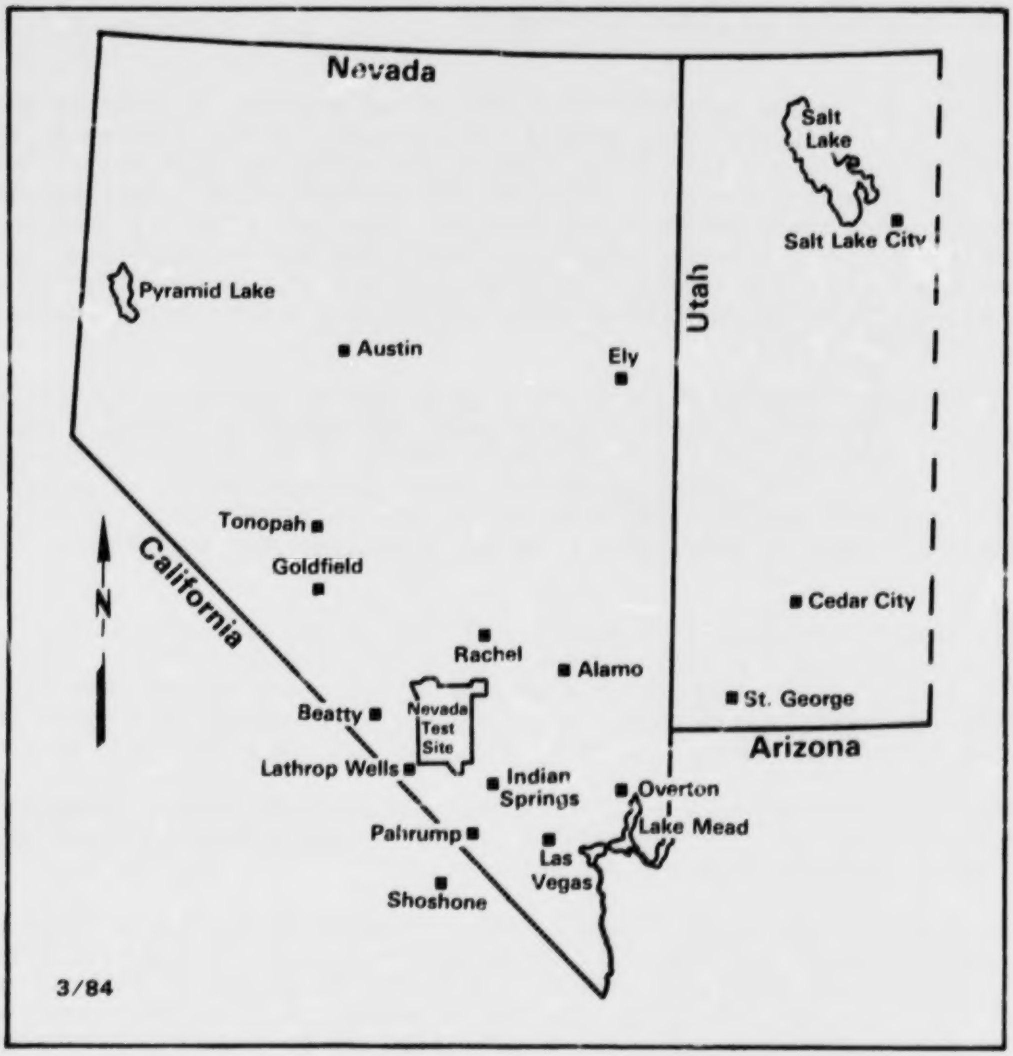

Nevada
Salt Lake
Salt Lake City
Pyramid Lake
Utah
Austin
Ely
Tonopah
California
Goldfield
N
Cedar City
Rachel
Alamo
Beatty
Nevada Test Site
St. George
Arizona
Lathrop Wells
Indian Springs
Overton
Lake Mead
Pahrump
Las Vegas
Shoshone
3/84

Figure 5. Noble Gas and Tritium Surveillance Network sampling locations.

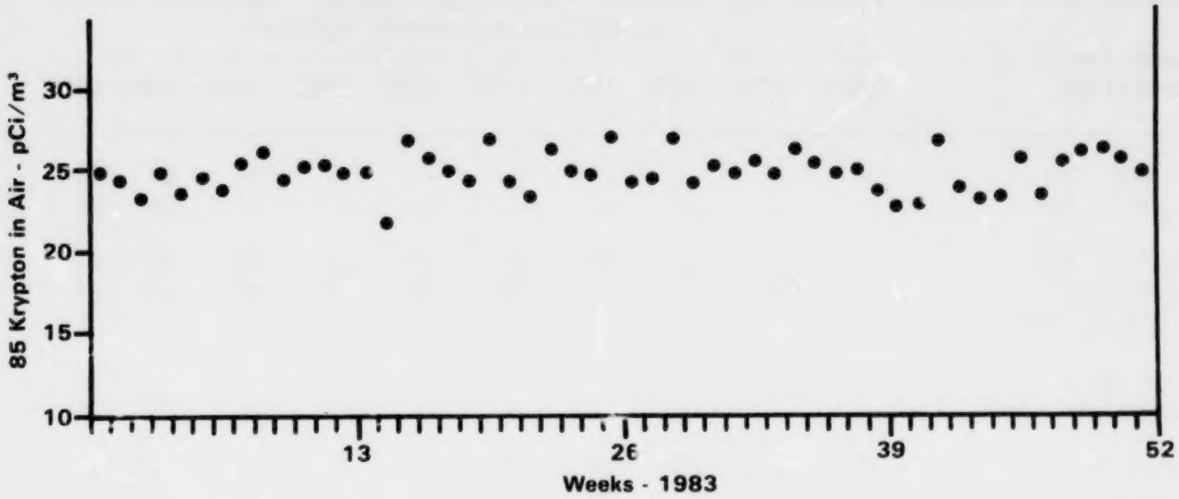


Figure 6. Weekley average distribution of krypton-85 concentration in air, 1983 data.

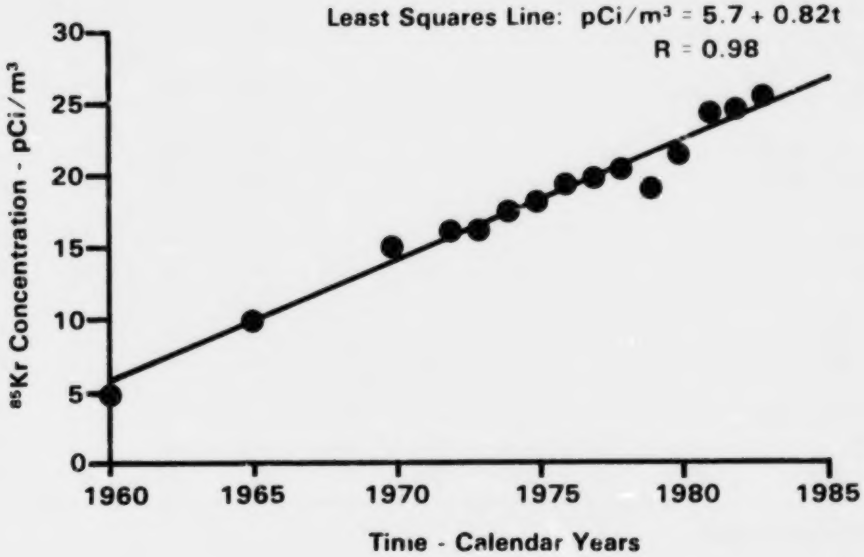


Figure 7. Trend in annual average krypton-85 concentration.

TABLE 2. ANNUAL AVERAGE KRYPTON-85 CONCENTRATIONS IN AIR, 1974-1983

Sampling Locations	Kr-85 Concentrations (pCi/m^3)									
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Alamo, Nev	--	--	--	--	--	--	--	27	24	25
Austin, Nev.	--	--	--	--	--	--	--	--	24	25
Beatty, Nev.	17	19	20	20	20	19	21	24	25	24
Diablo and Rachel, Nev.	17	18	19	19	20	19	21	24	26	24
Ely, Nev.	--	--	--	--	--	--	--	--	24	25
Goldfield, Nev.	--	--	--	--	--	--	--	--	25	24
Hiko, Nev.	17	17	17	19	20	19	21	24	26	--
Indian Springs, Nev.	--	20	20	20	20	19	21	24	24	25
NTS, Mercury, Nev.*	18	18	19	20	20	19	21	23	--	--
NTS, Area 51, Nev.*	17	18	20	19	20	19	21	24	--	--
NTS, BJY, Nev.*	19	19	20	21	22	21	23	26	--	--
NTS, Area 12, Nev.*	18	18	20	19	20	19	21	24	--	--
Tonopah, Nev.	18	17	19	19	20	18	21	25	24	25
Las Vegas, Nev.	17	18	18	20	20	--	--	24	24	24
Death Valley Jct., Calif.*	18	17	20	20	20	19	--	--	--	--
NTS, Area 15, Nev.*	--	--	--	--	--	19	21	25	--	--
NTS, Area 400, Nev.*	--	--	--	--	--	18	21	23	--	--
Lathrop Wells, Nev.	--	--	--	--	--	19	22	24	24	26
Pahrump, Nev.	--	--	--	--	--	--	--	23	24	24
Overton, Nev.	--	--	--	--	--	--	--	26	24	25
Cedar City, Ut.	--	--	--	--	--	--	--	--	25	24
St. George, Ut.	--	--	--	--	--	--	--	--	24	25
Salt Lake City, Ut.	--	--	--	--	--	--	--	--	25	25
Shoshone, CA	--	--	--	--	--	--	--	--	25	25
Network Average	18	18	19	20	20	19	21	24	24	25

*Stations discontinued
New stations
Station at Diablo was moved to Rachel in March 1979.

As in the past, tritium concentrations in atmospheric moisture samples from the off-NTS stations were generally below the minimum detectable concentration (MDC) of about 400 pCi/L water (Appendix Table E-3). The tritium concentrations observed at off-NTS stations were considered to be representative of environmental background. The geometric mean of the tritium concentrations for all offsite stations was evaluated as 0.08 pCi/mL of moisture, which is below the minimum detectable concentration of about 0.4 pCi/mL. The geometric standard deviation for the mean was determined to be 1.5.

Long-term Hydrological Monitoring Program

Network Design--

A major pathway for transport of radionuclides to individuals is via potable water. This program monitors possible radioactive contamination of potable water sources. The design is for a system to monitor the aquifers underlying, and surface waters on or near, sites where nuclear explosions have occurred. For aquifers, monitoring is limited by the availability of wells that tap those sources. For the sites considered herein, a suitable number of wells is present so that sufficient monitoring data are obtained.

The monitored locations for the NTS and nearby offsite areas are shown in Figures 8 and 9. For Projects Cannikin, Longshot and Milrow in Alaska; for Projects Rio Blanco and Rulison in Colorado; for Projects Dribble and Miracle Play in Mississippi; for Projects Faultless and Shoal in Nevada; and for Projects Gasbuggy and Gnome in New Mexico, the sampling locations are shown in Figures E-1 through E-12 in Appendix E.

Methods--

At each sampling location, four samples are collected. Two samples are collected in 500-mL glass bottles; one is used for tritium analysis and the other stored for use as a duplicate sample or to replace the original sample if it is lost in analysis. Two 3.5-L samples are filtered through 10 cm diameter membrane filters into cubitainers and acidified with HNO_3. One sample and the filter are gamma-scanned, the other sample is stored for duplicate analysis or for reanalysis as required.

Tritium and gamma spectrometric analyses are described in Appendix B. If the tritium concentration detected by the conventional analysis is less than 700 pCi/L, then the sample is reanalyzed using the enrichment method.

Results--

Table 3 lists the locations at which water samples were found to contain man-made radioactivity. Radioactivity in samples collected at most of these locations has been reported in previous years, the data for all samples analyzed are compiled in Appendix Tables E-6 through E-9 together with the percent of the relevant concentration guide listed in Appendix D. No man-made gamma-emitting radionuclides were detected in any of the other water samples analyzed.

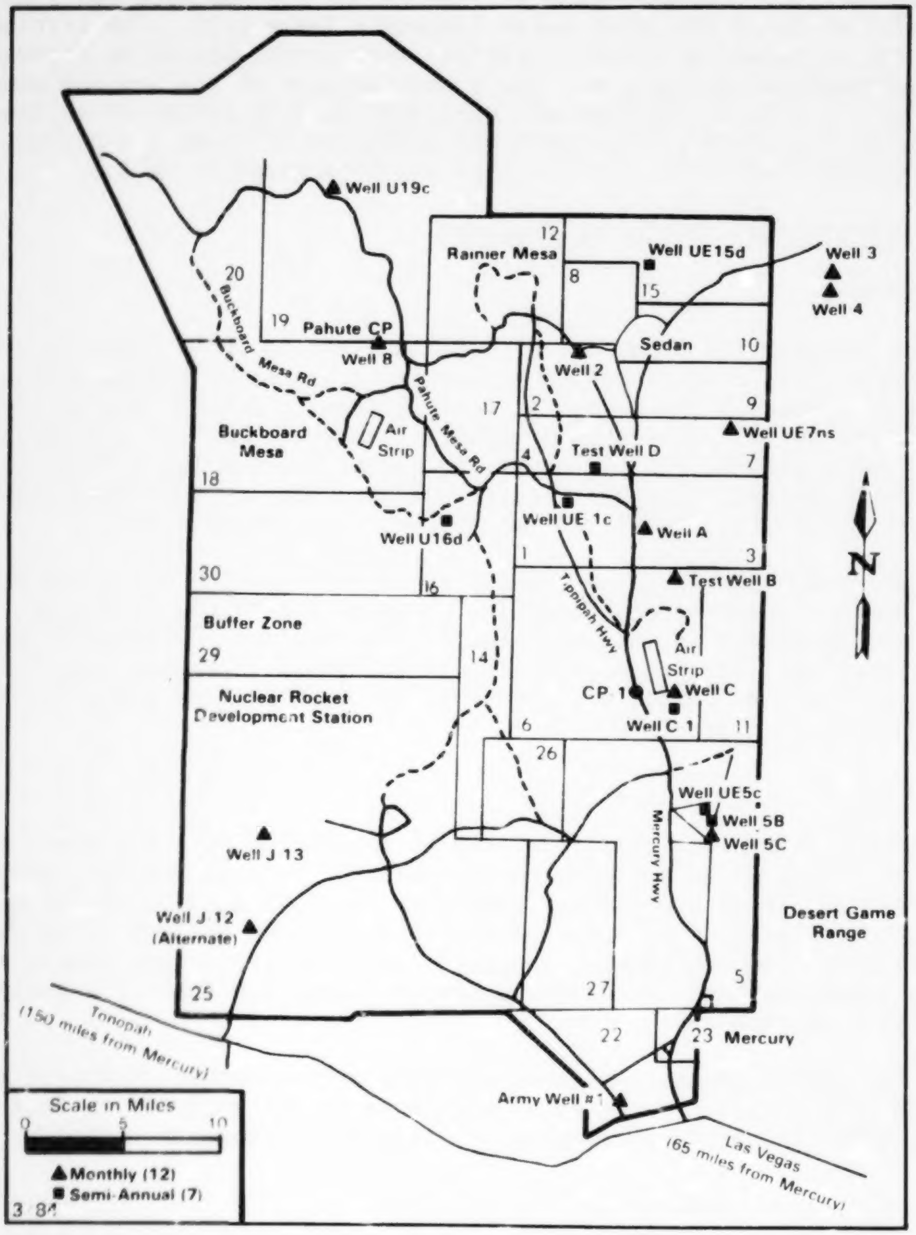

Well U19c
12
Rainier Mesa
Well UE15d
Well 3
Well 4
8
15
20
Buckboard Mesa Rd
19
Pahute CP
Well 8
Sedan
10
Well 2
Pahute Mesa Rd
17
2
9
Air Strip
Buckboard Mesa
Well UE7ns
4
Test Well D
7
18
Well UE 1c
Well U16d
Well A
1
3
30
Test Well B
16
Tippipah Hwy
N
Buffer Zone
29
14
Air Strip
CP 1
Well C
Nuclear Rocket Development Station
6
Well C 1
11
26
Well UE5c
Well 5B
Mercury Hwy
Well 5C
Well J 13
Desert Game Range
Well J 12 (Alternate)
5
25
27
Tonopah (150 miles from Mercury)
22
23
Mercury
Army Well #1
Scale in Miles
0
5
10
Las Vegas (65 miles from Mercury)
▲ Monthly (12)
■ Semi-Annual (7)
3 84

Figure 8. LTHMP sampling locations on the NTS.

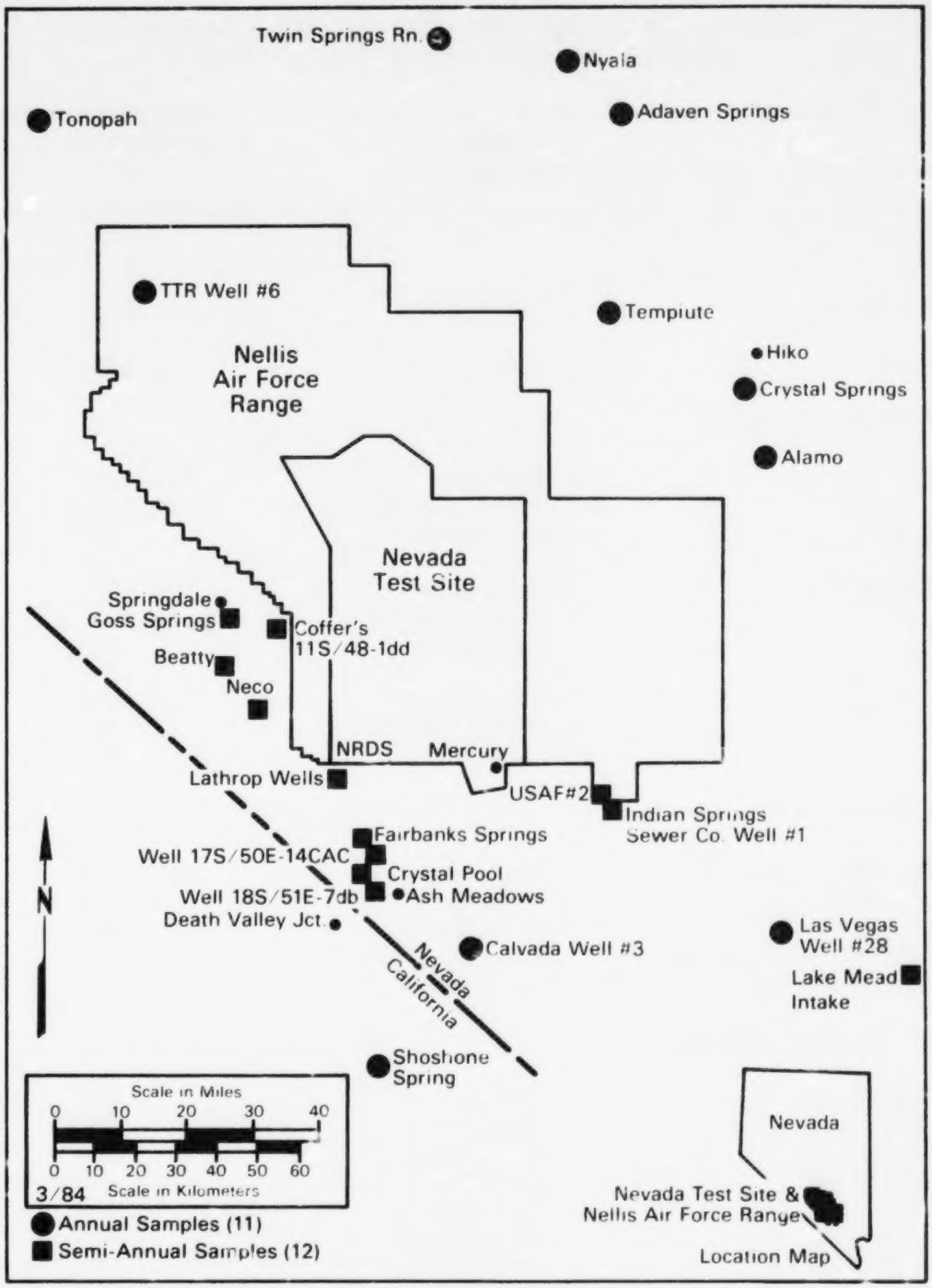

Twin Springs Rn.
Nyala
Tonopah
Adaven Springs
TTR Well #6
Tempiute
Hiko
Nellis
Air Force
Range
Crystal Springs
Alamo
Nevada
Test Site
Springdale
Goss Springs
Coffer's
11S/48-1dd
Beatty
Neco
NRDS
Mercury
Lathrop Wells
USAF#2
Indian Springs
Sewer Co. Well #1
Fairbanks Springs
Well 17S/50E-14CAC
Crystal Pool
Well 18S/51E-7db
Ash Meadows
Death Valley Jct.
N
Calvada Well #3
Las Vegas
Well #28
Lake Mead
Intake
Nevada
California
Shoshone
Spring
Scale in Miles
0
10
20
30
40
0
10
20
30
40
50
60
3/84
Scale in Kilometers
Annual Samples (11)
Semi-Annual Samples (12)
Nevada
Nevada Test Site &
Nellis Air Force Range
Location Map

Figure 9. LTHMP sampling locations near the NTS.

TABLE 3. WATER SAMPLING LOCATIONS WHERE SAMPLES CONTAINED MAN-MADE RADIOACTIVITY - 1983

Sampling Location	Type of Radioactivity	Concentration (pCi/L)
NTS (Nev.)		
Well UE7NS	Hydrogen-3	1500
ADAVEN (Nev.)	Hydrogen-3	650
PROJECT GNOME (N. Mex.)		
USGS Well 4	Hydrogen-3	330,000
	Strontium-90	9,000
	Cesium-137	10
USGS Well 8	Hydrogen-3	260,000
	Strontium-90	5,700
	Cesium-137	61
Well LRL-7	Hydrogen-3	23,000
	Strontium-90	13
	Cesium-137	220
PROJECT DRIBBLE (Miss.)		
Well HMH-1 through 11	Hydrogen-3	38-85,000
Well HM-S	Hydrogen-3	19,000
Well HM-L	Hydrogen-3	2,200
REECo Pit Drainage-B	Hydrogen-3	12,400
Half Moon Creek	Hydrogen-3	550
PROJECT LONG SHOT (Alaska)		
EPA Well 1	Hydrogen-3	820
Well WL-2	Hydrogen-3	290
Well GZ, No. 1	Hydrogen-3	3,800
Well GZ, No. 2	Hydrogen-3	270
Mud Pit No. 1	Hydrogen-3	600
Mud Pit No. 2	Hydrogen-3	590
Mud Pit No. 3	Hydrogen-3	740

None of the radionuclide concentrations found at the locations listed in Table 3 are expected to result in measurable radiation exposures to residents in the areas where the samples were collected. Well UE7NS is located on the NTS, and it is not used as a source of domestic water.

USGS Wells 4 and 8, which were contaminated with the reported nuclides during tracer studies years ago, are on private land at the Project Gnome site in New Mexico and are closed and locked to prevent their use. Well LRL-7 was used for the disposal of contaminated soil and salt. As a result, this well is expected to produce contaminated water.

The Project Dribble wells in Mississippi are about 1 mile from the nearest residence and are not sources of drinking water. The spring at Adaven is fed by melting snow containing tritium washed from the atmosphere. The concentration is only 3% of the EPA guide for continuous exposure and will decrease as the runoff ceases.

The shallow wells at the Project Long Shot site on Amchitka Island in Alaska are in an isolated location and are not sources of drinking water.

Milk Surveillance Network (MSN)

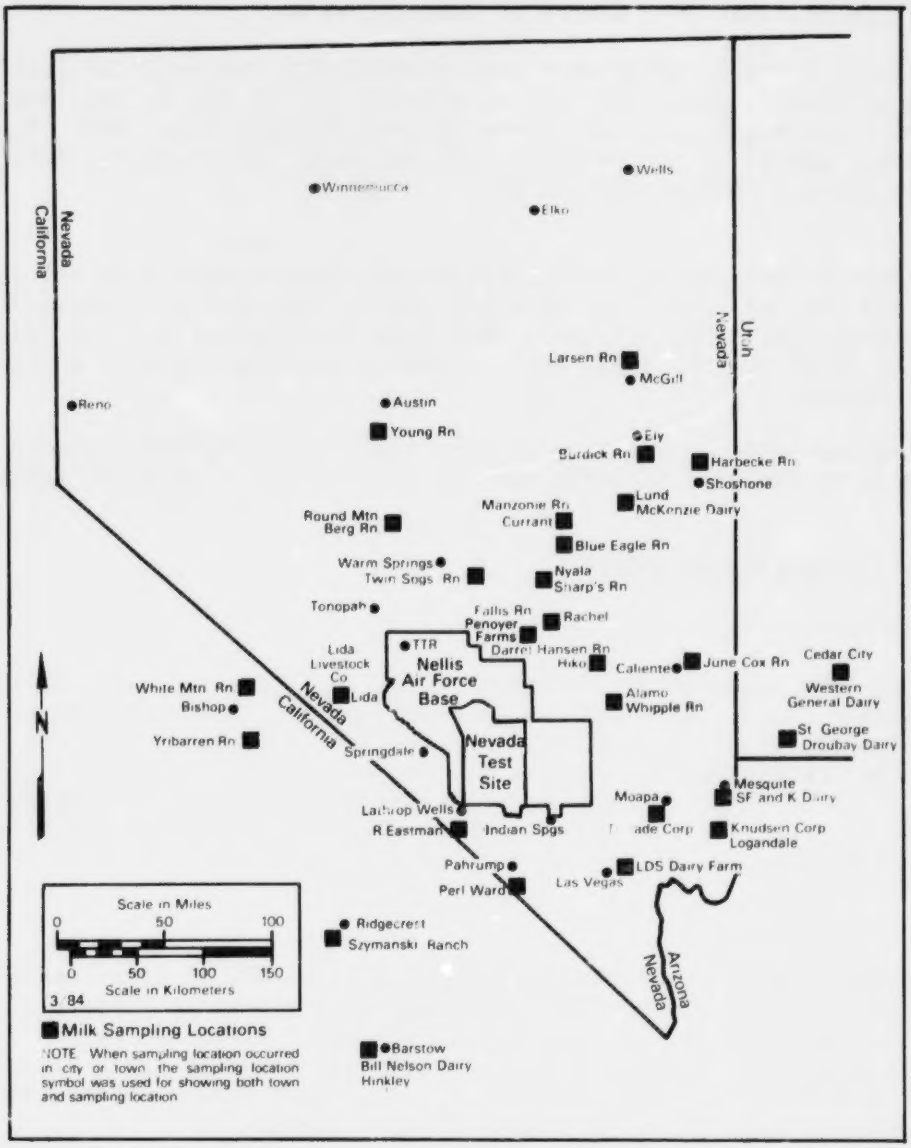
Network Design--

An important pathway for transport of radionuclides to humans is the air-forage-cow-milk chain. This pathway is monitored by EMSL-LV through analysis of milk. The design of the network is based on collections from areas likely to be affected by accidental releases from the NTS as well as from areas unlikely to be so affected. Additional considerations are: 1) a complete ring of stations to cover any eventuality, 2) samples from major milksheds as well as from family cows, and 3) availability of milk cows.

Methods--

The network consists of two major portions, the MSN at locations within 300 km of the NTS from which samples are collected quarterly (Figure 10) and the standby network (SMSN) at locations in all major milksheds west of the Mississippi River from which samples are collected annually. One exception to the latter portion of the network is Texas; the State Health Department performs the surveillance of the milksheds in that State.

The quarterly raw milk samples are collected by EPA monitors in 4-liter plastic containers (cubitainers) and preserved with formaldehyde. The annual milk samples are also collected in cubitainers and preserved with formaldehyde but they are collected by contacting State Food and Drug Administration Representatives, after notification of the Regional EPA offices by telephone, and mailed to EMSL-LV for analysis.


Nevada
California
Utah
Nevada
Wells
Winnemucca
Elko
Larsen Rn
McGill
Reno
Austin
Young Rn
Ely
Burdick Rn
Harbecke Rn
Shoshone
Lund
McKenzie Dairy
Manzonie Rn
Currant
Round Mtn
Berg Rn
Blue Eagle Rn
Warm Springs
Twin Sogs Rn
Nyala
Sharp's Rn
Tonopah
Fallis Rn
Penoyer Farms
Rachel
TTR
Darrel Hansen Rn
Lida Livestock Co
Nellis Air Force Base
Hiko
Caliente
June Cox Rn
Cedar City
Western General Dairy
White Mtn Rn
Bishop
Lida
Nevada
California
Alamo
Whipple Rn
St George
Droubay Dairy
Yribarren Rn
Springdale
Nevada Test Site
N
Mesquite
SF and K Dairy
Moapa
Lathrop Wells
R Eastman
Indian Spgs
ade Corp
Knudsen Corp
Logandale
Pahrump
LDS Dairy Farm
Perl Ward
Las Vegas
Scale in Miles
0
50
100
0
50
100
150
Scale in Kilometers
3/84
Ridgecrest
Szymanski Ranch
Arizona
Nevada
■ Milk Sampling Locations
Barstow
Bill Nelson Dairy
Hinkley

NOTE When sampling location occurred in city or town the sampling location symbol was used for showing both town and sampling location

Figure 10. Milk sampling locations within 300 km of the NTS.

All the milk samples are analyzed first for gamma-emitting nuclides by high-resolution gamma spectrometry and then for strontium-89 and strontium-90 by the methods outlined in Appendix B, after a portion is removed for tritium analysis. Occasionally a milk sample will turn sour, thus preventing the strontium analysis, but the other analyses can generally be performed.

Results--

The analytical results from the 1983 milk samples are summarized in Appendix Table E-10 and Table E-11 where the maximum, minimum, and average concentrations of tritium, strontium-89 and strontium-90 are shown for each sampling location. As shown in Table 4, the average concentrations of tritium and strontium-90 for the whole network are similar to the network averages for previous years. However, from the results of intercomparison samples used for quality assurance, the strontium results are considered to be low by about 25 percent in the fourth quarter of 1983.

TABLE 4. NETWORK ANNUAL AVERAGE CONCENTRATIONS OF TRITIUM AND STRONTIUM-90 IN MILK, 1975 - 1983

	Average Concentrations - pCi/L	
Year	H-3	Sr-90
1975	<400	<3
1976	<400	<2
1977	<400	<2
1978	<400	1.2
1979	<400	<3
1980	<400	<2
1981	<400	1.9
1982	<400	1.2
1983	<400	0.8

Other than naturally occurring potassium-40, radionuclides were not detected by gamma spectrometry in any of the samples from the MSN.

The tritium and strontium-90 concentrations for the whole milk network were plotted versus probits. The tendency of the data to fit one straight line indicates that the data represent a single source, which appears to be atmospheric deposition. These results are consistent with the results obtained for the Pasteurized Milk Network shown in Figure 11. This network is operated by the Eastern Environmental Radiation Laboratory in Montgomery, Alabama.

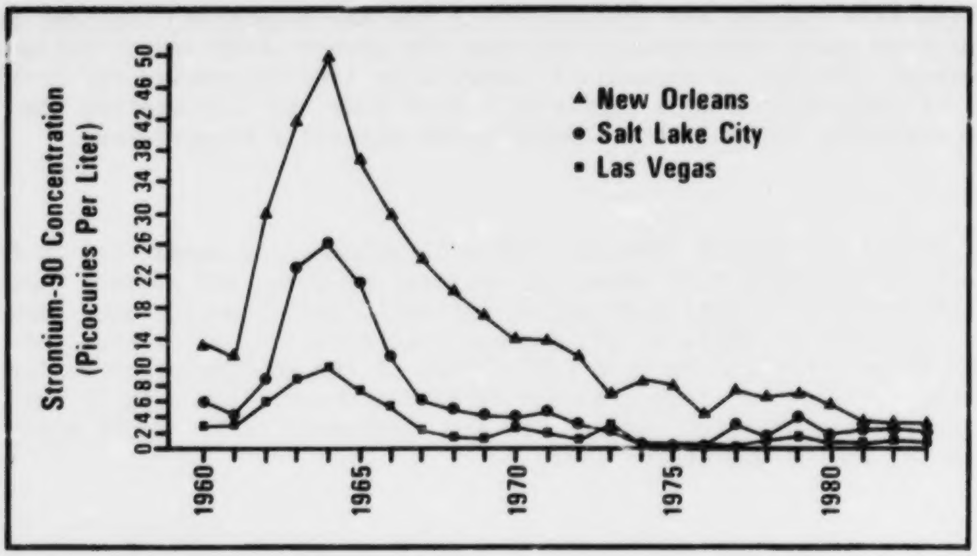


Figure 11. Strontium-90 concentration in Pasteurized Milk Network samples.

Biomonitoring Program

Objective--

The pathways for transport of radionuclides to man include air, water, and food. Monitoring of air, water, and milk are discussed above, leaving garden vegetables and meat as the other potential components of exposure to near offsite residents. This program was established to document uptake from these sources. From 1957 through 1981, this was named the Animal Investigation Program. A summary report for those years was published recently (Smith and Black 1984).

Methods--

Samples of muscle, lung, liver, kidney, blood, and bone are collected periodically from cattle purchased from a commercial herd that grazes areas northeast of the NTS. These samples are analyzed for gamma emitters, tritium, strontium, and plutonium. Also, each November and December, bone and kidney samples from desert bighorn sheep collected throughout southern Nevada (see Figure 12) are donated by licensed hunters and are analyzed. These kinds of samples have been collected and analyzed for up to 26 years to determine long term trends. In the late summer of alternate years, kilogram samples of a leaf, a fruit, and a root vegetable will be collected from gardens in three

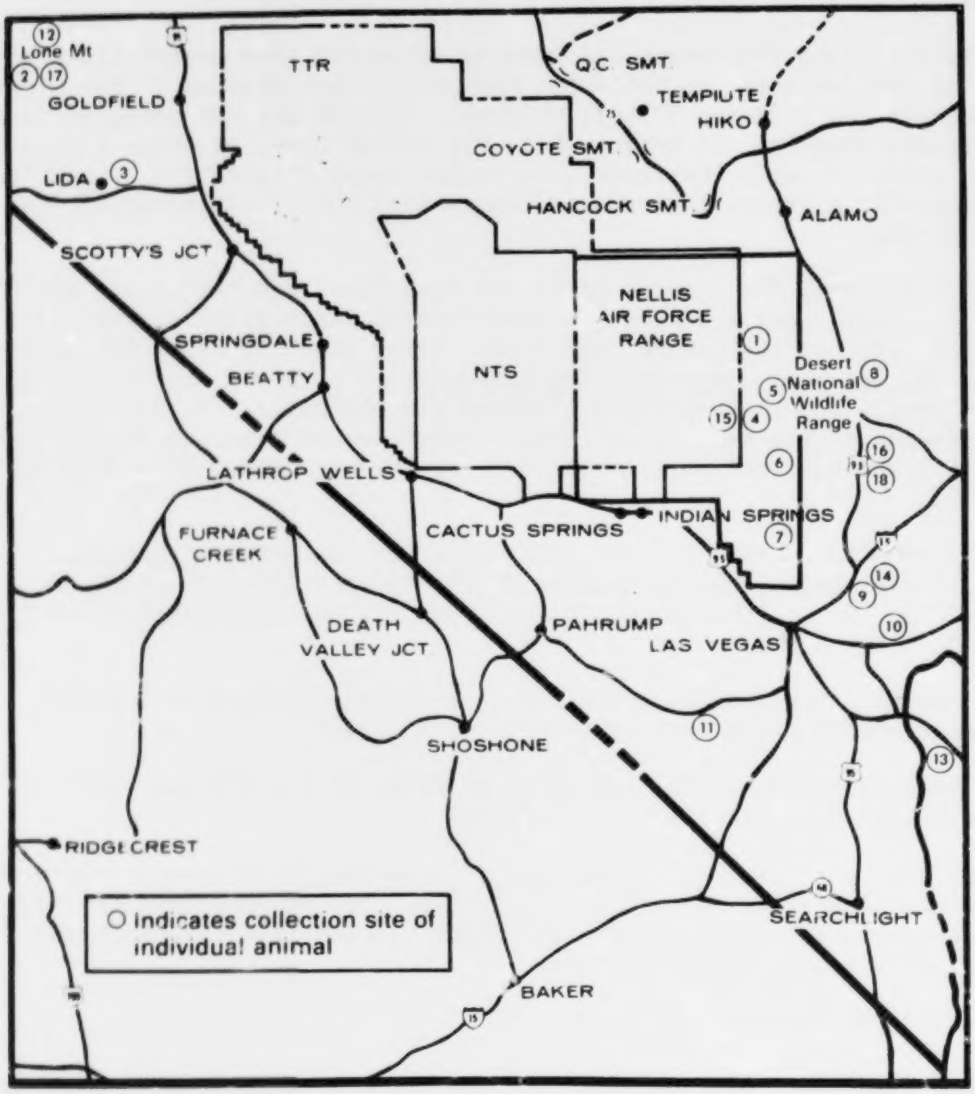

⑫
Lone Mt
② ⑰
GOLDFIELD
LIDA ③
TTR
Q.C. SMT
TEMPIUTE
HIKO
COYOTE SMT
HANCOCK SMT
ALAMO
SCOTTY'S JCT
SPRINGDALE
BEATTY
NTS
NELLIS
AIR FORCE
RANGE
①
Desert
National
Wildlife
Range
⑧
⑤
⑮ ④
⑥
⑯
⑱
LATHROP WELLS
INDIAN SPRINGS
⑦
FURNACE
CREEK
CACTUS SPRINGS
⑭
⑨
⑩
DEATH
VALLEY JCT
PAHRUMP
LAS VEGAS
⑪
SHOSHONE
⑬
RIDGECREST
○ Indicates collection site of
individual animal
SEARCHLIGHT
BAKER

Figure 12. Collection sites for bighorn sheep samples.

communities northeast of the NTS and a similar set of samples from a garden in Las Vegas. These vegetable samples are analyzed for gamma emitters, tritium, strontium, and plutonium.

Results--

Analytical data from bones and kidneys collected from desert bighorn sheep during 1982 are presented in Table 5. Cesium-137 was detected in the kidneys of two animals (24 ± 17 and 38 ± 21 pCi/kg). Tritium was not detected in any of the kidneys sampled. Strontium-90 levels in the bones (average 1.59 pCi/g ash) are consistent with the reports in recent years (Figure 13). Counting errors generally exceeded the reported concentrations of plutonium-238 and -239 in the bone ash.

Analytical data for samples collected from four beef cattle are presented in Table 6. These cattle grazed the Steve Medlin Ranch which is the first ranch to the east of the Nevada Test Site. Other than the naturally ocurring potassium-40, the only gamma-emitting radionuclide detected, was Cesium-137 in one liver sample (23 ± 12 pCi/kg). Tritium and plutonium-238 and -239 were not detected in any of the samples analyzed. Strontium-90 detected in the bones averaged 1.4 pCi/g of ash which continues the downward trend of recent years (Figure 13).

Three reports summarizing the activities carried out by the Animal Investigation Program (the predecessor of the Biomonitoring Program) are at various stages in the publishing process. One has been published as mentioned above. The other two are:

- a report on the radionuclide uptake studies conducted at the NTS Experimental Dairy Farm from 1963 to 1981, and

- a report describing the migration patterns of the NTS deer herd as observed during the years 1977 to 1981.

Other than potassium-40, gamma-emitting radionuclides were not detected in any of the vegetables collected from the four Nevada locations in 1982. Tritium concentrations were also below detectable limits. Strontium and plutonium analyses are shown in Table 7.

EXTERNAL EXPOSURE MONITORING

Thermoluminescent Dosimetry Network

External radiation exposure of people is due primarily to medical sources and to natural sources such as cosmic radiation and naturally occurring radioactivity in soil. Radioactivity from fallout generated by past atmospheric nuclear testing causes approximately 0.6 percent of a person's total exposure. Until 1965, film badges were used to document external exposure, but TLD's gradually replaced film as the measurement instrument because of their greater sensitivity and precision. From 1970 to 1974 the EMSL-LV used the TLD-12 dosimeter but changed to the TLD-200 in 1975.

TABLE 5. RADIONUCLIDE CONCENTRATIONS IN SHEEP TISSUE SAMPLES

Bighorn Sheep (Collected Dec. 1982)	Bone 90Sr (pCi/g Ash) (pCi/kg)*	Bone 238Pu (pCi/g Ash) (pCi/kg)*	Bone 239Pu (pCi/g Ash) (pCi/kg)*	Kidney K(g/kg)* 137Cs(pCi/kg)* 3H(pCi/l)‡
1	2.5 ± 0.092	0.0013 ± 0.003**	0.019 ± 0.0053	2.8 ± 0.4
	640 ± 230	0.33 ± 0.77	4.9 ± 1.4	<35
				<380
2	1.7 ± 0.07	-0.0013 ± 0.0062**	0.0027 ± 0.004**	3.4 ± 0.4
	570 ± 240	-0.46 ± 2.2	0.92 ± 1.4	<45
				<390
3	0.8 ± 0.05	0.0017 ± 0.0035**	0.0027 ± 0.0045**	4.4 ± 0.9
	280 ± 190	0.6 ± 1.3	0.96 ± 1.6	<97
				<520
4	2.4 ± 0.089	0.00027 ± 0.0013**	0.00055 ± 0.0018**	2.6 ± 0.5
	920 ± 340	0.1 ± 0.48	0.21 ± 0.68	<36
				<200
5	1.6 ± 0.074	0.0019 ± 0.0037**	0.013 ± 0.0043	2.0 ± 0.4
	580 ± 260	0.67 ± 1.3	4.7 ± 1.5	<34
				<470
6	2.0 ± 0.092	0.00034 ± 0.0016**	0.0024 ± 0.0043**	2.6 ± 0.7
	690 ± 320	0.12 ± 0.55	0.83 ± 1.5	<61
				Sample Lost
7	1.9 ± 0.083	0.00034 ± 0.0016**	0.003 ± 0.0047**	3.1 ± 0.4
	500 ± 220	0.088 ± 0.41	0.79 ± 1.2	<38
				<250
8	1.6 ± 0.069	-0.0015 ± 0.0067**	0.0011 ± 0.0029**	2.0 ± 0.8
	380 ± 160	-0.34 ± 1.6	0.26 ± 0.69	<64
				<250
9	0.47 ± 0.041	-0.00039 ± 0.0018**	0.0031 ± 0.0052**	3.2 ± 0.4
	150 ± 140	-0.13 ± 0.59	1.0 ± 1.7	25 ± 17
				<420
10	0.75 ± 0.5	0.00064 ± 0.0021**	0.0016 ± 0.0033**	4.2 ± 1.1
	190 ± 120	0.16 ± 0.52	0.39 ± 0.82	<120
				<400

---

*Wet weight.
**Counting error exceeds reported activity.
‡Aqueous Portion of Kidney Tissue.

Continued

TABLE 5. CONTINUED

Bighorn Sheep (Collected Dec. 1982)	Bone 90Sr (pCi/g Ash) (pCi/kg)*	Bone 238Pu (pCi/g Ash) (pCi/kg)*	Bone 239Pu (pCi/g Ash) (pCi/kg)*	Kidney K(g/kg)* 137Cs(pCi/kg)* 3H(pCi/l)‡
11	1.5 ± 0.078 560 ± 300	-0.00097 ± 0.0045** -0.37 ± 1.7	0.00033 ± 0.0015** 0.12 ± 0.57	2.8 ± 0.5 <57 <510
12	0.48 ± 0.43 120 ± 110	0.00095 ± 0.0026** 0.24 ± 0.63	-0.00095 ± 0.0025** 0.24 ± 0.63	5.0 ± 0.5 <52 <120
13	0.62 ± 0.44 240 ± 170	-0.00067 ± 0.0031** -0.26 ± 1.2	-0.00067 ± 0.0031** -0.26 ± 1.2	3.1 ± 0.4 <39 <290
14	0.78 ± 0.48 270 ± 170	0.002 ± 0.0036** 0.7 ± 1.2	-0.00029 ± 0.0013** -0.1 ± 0.46	2.1 ± 0.3 <36 <270
15	1.3 ± 0.061 490 ± 230	-0.00065 ± 1.003** -0.25 ± 1.2	0.0013 ± 0.003** 0.49 ± 1.2	3.6 ± 0.4 <39 <120
16	1.2 ± 0.082 360 ± 250	0.00 ± 0.0016** 0.00 ± 0.48	0.00069 ± 0.0023** 0.21 ± 0.69	2.5 ± 0.49 <63 Sample Lost
17	4.3 ± 0.12 1030 ± 290	0.0024 ± 0.0051** 0.59 ± 1.2	0.0019 ± 0.0046** 0.47 ± 1.1	3.5 ± 0.4 <39 Sample Lost
18	2.7 ± 0.096 630 ± 230	0.0013 ± 0.0042** 0.31 ± 1.0	0.0026 ± 0.006** 0.61 ± 1.4	2.7 ± 0.41 38 ± 21 Sample Lost
Median	1.55 495	0.00034** 0.11**	0.00175** 0.48**	3.95 <39 <385
Range	0.47 - 4.3 120 - 1030	-0.0015** - 0.0024** -0.46** - 0.7**	-0.00095** - 0.019 -0.26** - 4.9	2.0 - 5.0 25 - <120 <120 - <520

*Wet weight.
**Counting error exceeds reported activity.
‡Aqueous Portion of Kidney Tissue.

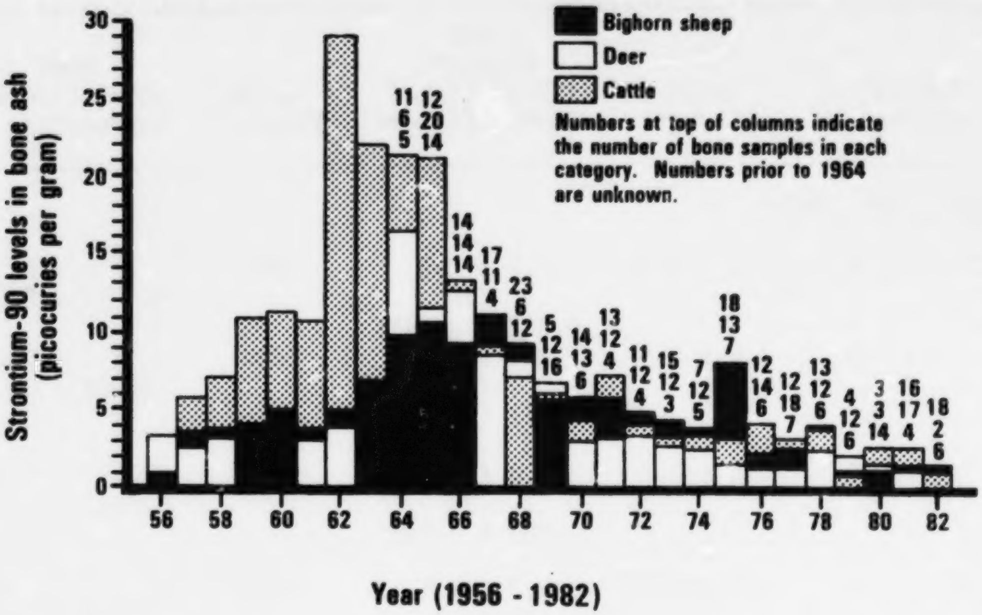


Figure 13. Average strontium-90 concentration in animal bone.

Network Design--

The TLD network is designed to measure environmental radiation exposure at a location rather than to an individual because of the many uncertainties associated with personnel monitoring. Several individuals, some residing within and some residing without estimated fallout zones from past nuclear tests at the NTS, have been monitored so that any correlations that may exist between personnel and environmental monitoring could be obtained. The network consists of 86 monitored locations encircling the NTS with some concentration in the area of the estimated fallout zones (Figure 14). This arrangement permits an estimate of average background exposure; yet any increase due to NTS activities can be detected.

TABLE 6. RADIONUCLIDE CONCENTRATIONS IN CATTLE TISSUE SAMPLES - 1983

	MUSCLES K(g/kg*)	LUNGS K(g/kg*)	LIVER K(g/kg*) 137Cs(pCi/kg) 239Pu(pCi/kg*)	BLOOD 3H(pCi/l)	BONE 90Sr(pCi/g ash) 239Pu(pCi/g ash)
MEDLIN RANCH, Oct 1983:					
BOV-1	5.9 ± 0.3	1.2 ± 0.4	2.8 ± 0.3 <26 0.092 ± 0.16**	<400	1.8 ± 0.08 0.0017 ± 0.004**
BOV-2	3 ± 0.3	1.2 ± 0.5	2.1 ± 0.2 <24 0.71 ± 0.75**	<400	1.1 ± 0.064 0.002 ± 0.0046**
BOV-3	4.9 ± 0.4	2.6 ± 0.7	2.8 ± 0.4 <24 0.009 ± 0.04**	<400	0.97 ± 0.06 0.0051 ± 0.0076**
BOV-4	4.1 ± 0.3	5.5 ± 0.7	5.2 ± 0.4 23 ± 14 0.15 ± 0.23**	<400	1.7 ± 0.084 0.004 ± 0.007**

*Wet weight.
**Counting error exceeds reported activity.

TABLE 7. RADIONUCLIDES IN SELECTED VEGETABLE CROPS - 1982

Vegetation Date	Sr-89 (pCi/g ash) (pCi/kg*)	Sr-90 (pCi/g ash) (pCi/kg*)	Pu-238 (pCi/g ash) (pCi/kg*)	Pu-239 (pCi/g ash) (pCi/kg*)
Las Vegas				
Lettuce	0.65 ± 8.9**	0.15 ± 0.06	0.0009 ± 0.0029**	0.032 ± 0.0087
06-17-82	6.3 ± 87**	1.4 ± 0.58	0.008 ± 0.028**	0.32 ± 0.084
Zucchini	-3.1 ± 15.0**	0.13 ± 0.26**	-0.00044 ± 0.0016**	0.0044 ± 0.0058**
07-01-82	-18 ± 84**	0.11 ± 1.5**	-0.0019 ± 0.0089**	0.025 ± 0.033**
Turnips	-1.2 ± 7.7**	0.14 ± 0.24**	-0.0004 ± 0.0019**	0.022 ± 0.0066
08-04-82	-14 ± 87**	1.6 ± 2.6**	-0.0045 ± 0.021**	0.25 ± 0.07
Hiko				
Lamb's Quarter	-4.3 ± 6.9**	0.33 ± 0.087	0.0006 ± 0.0027**	0.055 ± 0.015
08-04-82	-160 ± 250**	12 ± 3.2	0.022 ± 0.1**	2.0 ± 0.53
Zucchini	-3.7 ± 28**	0.31 ± 0.77**	0.0048 ± 0.0064**	0.0037 ± 0.0055**
08-04-82	-24 ± 180**	2.1 ± 5.0**	0.032 ± 0.042**	0.024 ± 0.037**
Beets	-70 ± 110**	3 ± 3.3**	0.0047 ± 0.0065**	0.0064 ± 0.0078**
08-04-82	-1200 ± 1800**	48 ± 52**	0.075 ± 0.1**	0.11 ± 0.12**
Rachel				
Turnip Greens	0.41 ± 3.4**	5.9 ± 1.3	0.0065 ± 0.011**	0.011 ± 0.016**
10-24-82	7.0 ± 57**	10 ± 2.2	0.11 ± 0.21**	0.19 ± 0.28**
Zucchini	1.5 ± 9.0**	0.37 ± 0.11	-0.00032 ± 0.0015**	0.0016 ± 0.0034**
08-04-82	11 ± 65**	2.7 ± 0.76	-0.0023 ± 0.011**	0.011 ± 0.024**
Turnips	-2.0 ± 0.59**	0.5 ± 0.51**	0.06 ± 0.002**	0.0014 ± 0.0037**
10-24-82	-15 ± 45**	3.8 ± 3.9**	0.0 ± 0.16**	0.011 ± 0.028**
Adaven				
Zucchini	-13 ± 58**	0.95 ± 2.4**	0.0037 ± 0.0062**	0.00093 ± 0.0031**
09-01-82	-64 ± 280**	4.6 ± 11**	0.018 ± 0.03**	0.0045 ± 0.015**

* Wet weight

** Counting error exceeds reported activity

Methods--

In 1983 the TLD Network consisted of 86 stations at both inhabited and uninhabited locations within a 300-km radius of the CP-1. Each station is equipped with three Harshaw thermoluminescent dosimeters (TLD's) to measure gamma exposures resulting from environmental background as well as accidental releases of gamma-emitting radioactivity. Within the area covered by the Network, 46 offsite residents wore dosimeters during 1983. All TLD's were exchanged quarterly.

The Harshaw Model 2271-G2 (TLD-200) dosimeter consists of two small "chips" of dysprosium-activated calcium fluoride mounted in a window of Teflon plastic attached to a small aluminum card. An energy compensation shield of 1.2-mm thick cadmium metal is placed over the card containing the chips, and the shielded card is then sealed in an opaque plastic card holder. Three of these dosimeters are placed in a secured, rugged, plastic housing 1 meter above ground level at each station to standardize the exposure geometry. One dosimeter is issued to each of 46 offsite residents who are instructed in its proper wearing.

After appropriate corrections were made for exposure accumulated during shipment between the laboratory and the monitoring location, and for the response factor, the six TLD chip readings for each station were averaged. The average value for each station was then compared to the values obtained during the previous four quarters at that station to determine whether the new value was within the range of previous background values for that station. The result from each of the personnel dosimeters was compared to the average background value measured at the nearest fixed station over the previous four quarters.

The smallest exposure above background radiation that can be determined from these TLD readings depends primarily on the magnitude of variations in the natural background exposure rate at the particular station. In the absence of other independent exposure rate measurements, the present exposure rate is compared with valid prior measurements of natural background. Typically, the smallest net exposure detectable at the 99 percent confidence level for a 90-day exposure period would be 1 to 5 mR above background.

Depending on location, the background ranges from 15 to 35 mR per quarter. The term "background," as used in this context, refers to naturally occurring radioactivity plus a contribution from residual manmade fission products, such as worldwide fallout.

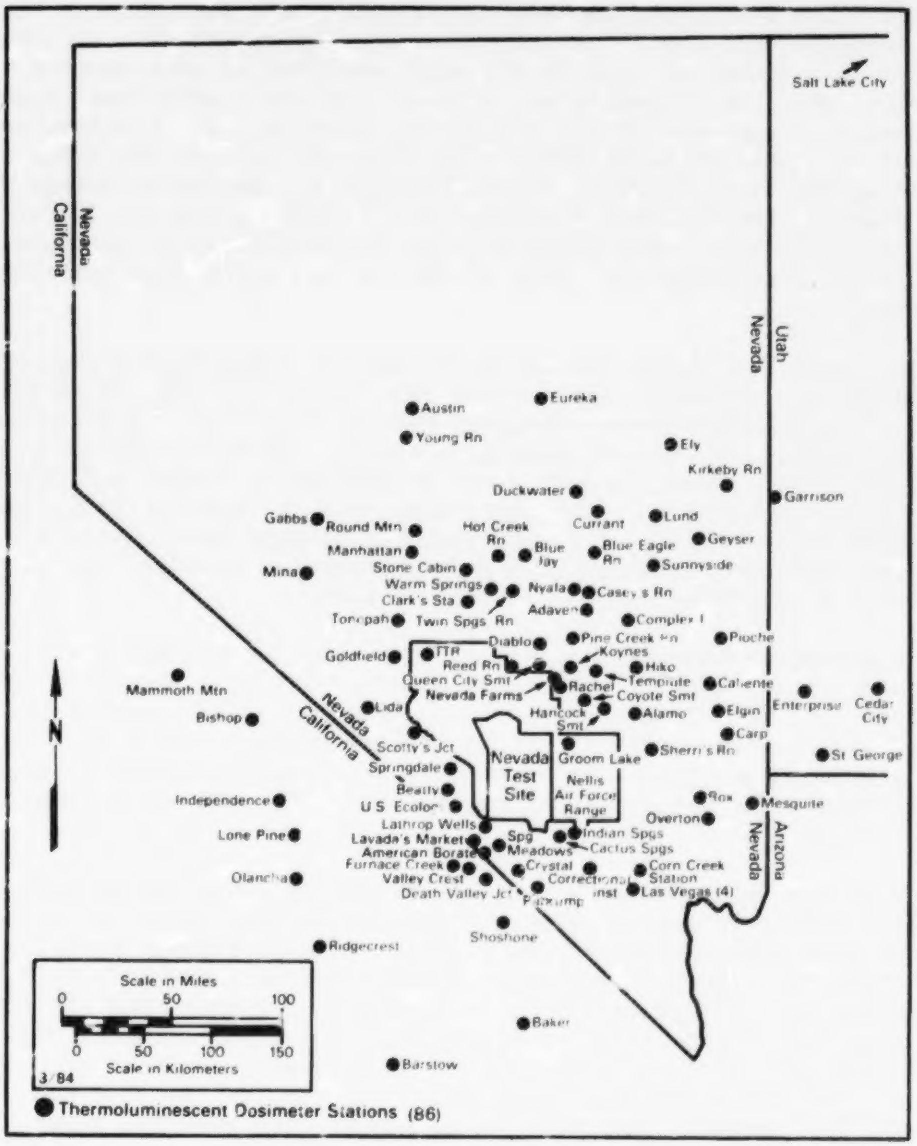

Salt Lake City
Nevada
California
Utah
Nevada
Austin
Eureka
Young Rn
Ely
Kirkeby Rn
Duckwater
Garrison
Gabbs
Round Mtn
Hot Creek Rn
Currant
Lund
Geyser
Manhattan
Blue Jay
Blue Eagle Rn
Sunnyside
Mina
Stone Cabin
Warm Springs
Nyala
Casey's Rn
Clark's Sta
Adaven
Tonopah
Twin Spgs Rn
Complex I
Diablo
Pine Creek Rn
Pioche
Goldfield
TTR
Reed Rn
Koynes
Hiko
Queen City Smt
Tempiute
Caliente
Enterprise
Cedar City
Mammoth Mtn
Nevada Farms
Rachel
Coyote Smt
Lida
Hancock Smt
Alamo
Elgin
Bishop
Nevada
California
Carp
Scotty's Jct
Sherri's Rn
St George
N
Springdale
Nevada Test Site
Groom Lake
Nellis Air Force Range
Beatty
U S Ecolor
Rox
Mesquite
Independence
Lathrop Wells
Overton
Lone Pine
Lavada's Market
Spg Meadows
Indian Spgs
American Borate
Cactus Spgs
Furnace Creek
Crystal
Corn Creek Station
Olancha
Valley Crest
Correctional Inst
Las Vegas (4)
Death Valley Jct
Pahrump
Nevada
Arizona
Shoshone
Ridgecrest
Scale in Miles
0
50
100
0
50
100
150
Scale in Kilometers
3/84
Baker
Barstow
Thermoluminescent Dosimeter Stations (86)

Figure 14. Locations monitored with TLD's.

Results--

Appendix Table E-12 lists the maximum, minimum, and average dose equivalent rate (mrem/day) and the annual adjusted dose equivalent rate (average in mrem/day times the number of days in the year) measured at each station in the Network during 1983. No allowance was made for the small additional exposure due to the neutron component of the cosmic ray spectrum. Six stations exhibited exposure in excess of background. They were the Currant and Groom Lake stations during the first Quarter, Baker, Mammoth Mt., and Warm Springs during the second quarter, and the Sherri's Ranch station during the 4th Quarter of 1983. Each exposure was investigated and the possible cause of exposure noted in the Quarterly Interim Report. None of the net exposures were attributed to NTS activities.

Appendix Table E-13 lists the personnel number; associated background station; the maximum, minimum, and average dose equivalent rate (mrem/d); and the annual dose equivalent (mrem) measured for each offsite resident monitored during 1983. Eighteen dosimeters worn by residents exhibited exposures in excess of background. These exposures are attributed to higher background levels in the residence than at the background station location or to occupational exposure (Nos. 49, 52, 57). Usually, the average dose equivalent rates of the offsite residents is lower than their background stations due to the shielding provided by their homes or places of work.

Table 8 shows that the average annual dose rate for the Dosimetry Network is consistent with the Network average established in 1975. Annual doses decreased from 1971 to 1975 with a leveling trend since 1975, except for a high bias in the 1977 results attributed to mechanical readout problems. The trend shown by the Network average is indicative of the trend exhibited by individual stations, although this average is also affected by the mix of stations at different altitudes (note Figure 15).

Because of the great range in the results, 42 to 140 mrem, an average for the whole area monitored may be inappropriate for estimating individual exposure. This would be particularly true if the exposure of a particular resident were desired. Since environmental radiation exposure can vary markedly with both altitude and the natural radioactivity in the soil, and since the altitude of the TLD station location is relatively easy to obtain, the measured dose rates for 1975 to 1983 were plotted as a function of altitude. As most of Nevada lies between 2,000 and 6,000 feet above mean sea level, this range was used and was split into two sections for plotting purposes. The results, shown in Figure 15, indicate that the average exposure at altitudes between 4,000 and 6,000 feet is about 20 mrem/a higher than that at altitudes between 2,000 and 4,000 feet, although both curves follow the same trend as the overall averages listed in Table 8. Thus, if an individual does not live near a monitored location, an estimate of exposure could be based on the altitude of his residence rather than on the average for the whole area monitored.

TABLE 8. DOSIMETRY NETWORK SUMMARY FOR THE YEARS 1971 - 1983

Year	Maximum	Minimum	Average
	Environmental Radiation Dose Rate (mrem/y)		
1971	250	102	160
1972	200	84	144
1973	180	80	123
1974	160	62	114
1975	140	51	94
1976	140	51	94
1977	170	60	101
1978	150	50	95
1979	140	49	92
1980	140	51	90
1981	142	40	90
1982	139	42	88
1983	140	42	87

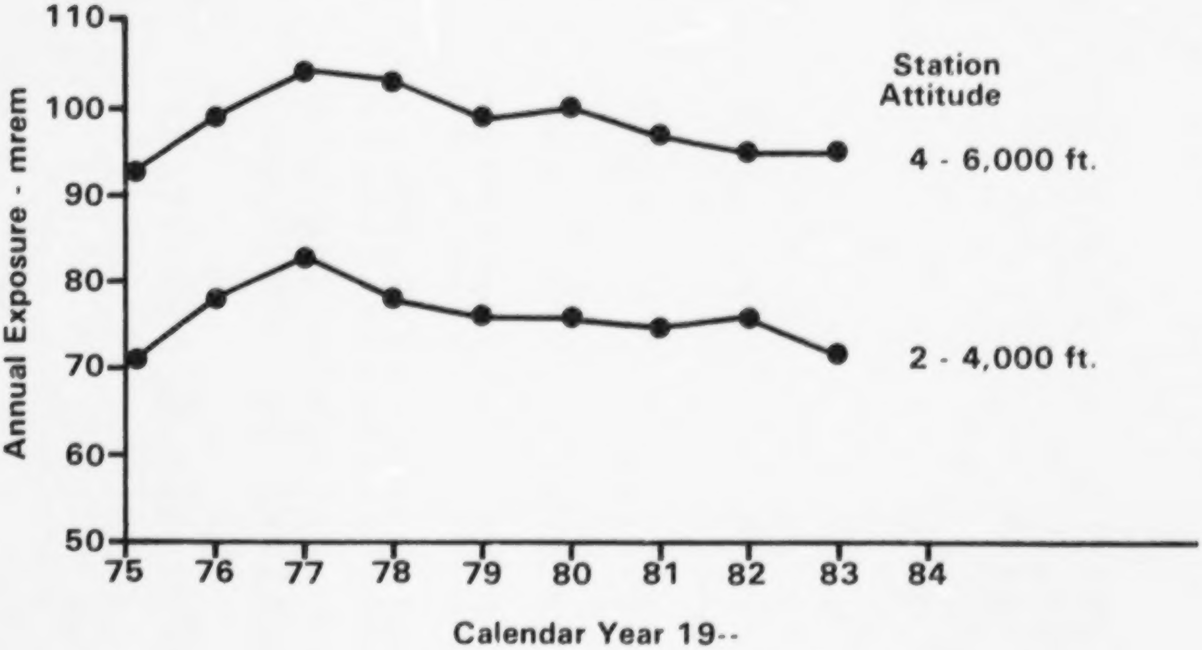


Figure 15. Average annual TLD exposure as a function of station altitude.

Pressurized Ion Chamber Network (PIC)

This network is located at the 15 Community Monitoring Stations identified on Figure 2 plus stations at Complex I, Furnace Creek, Nyala, Stone Cabin Ranch, Tikaboo Valley, Twin Springs, and Lathrop Wells. The PIC used is manufactured by Reuter-Stokes and the output is recorded on both paper tape, so the station manager can observe the response, and on cassette tape. The cassette tapes are read into a computer at EMSL-LV each week. The computer output is a table containing hourly, daily, and weekly summaries of the maximum, minimum, average, and standard deviation of the gamma exposure rate.

The data for 1983 are displayed in Table 9 as the average μR/hr and annual mR from each station. When these data are compared to the TLD results for the same 22 stations, it is found that the PIC response is about 34% higher than the TLD response. This is attributed, primarily, to the difference in energy response (plateau) of the two instruments.

TABLE 9. PRESSURIZED ION CHAMBER READINGS - μR/HOUR

			EXPOSURE RATE (MICRO-R/H)*			ANNUAL ADJUSTED EXPOSURE
STATION LOCATION	MEASUREMENT PERIOD		MAX.	MIN.	AVG.	(MR/A)
ALAMO, NV	83/01/01	83/12/30	20.1	7.7	12.80	112
AUSTIN, NV	83/01/01	83/12/29	23.5	14.3	18.36	161
BEATTY, NV	83/01/01	83/12/30	19.9	6.4	15.85	139
CEDAR CITY, UT	83/01/03	83/12/30	18.5	8.0	10.35	91
COMPLEX 1, NV	83/06/06	83/12/29	34.5	15.8	18.29	160
ELY, NV	83/01/01	83/12/30	16.5	10.2	12.09	106
FURNACE CREEK, CA	83/11/10	83/12/30	12.6	9.5	10.21	89
GOLDFIELD, NV	83/01/01	83/12/29	19.6	12.1	14.33	126
INDIAN SPRINGS, NV	83/01/01	83/12/30	12.1	6.3	7.97	70
LAS VEGAS (UNLV) NV	83/01/01	83/12/30	14.5	5.7	6.99	61
LATHROP WELLS, NV	83/01/01	83/12/29	35.4	5.3	12.58	110
NYALA, NV	83/01/01	83/12/30	18.6	10.3	12.43	109
OVERTON, NV	83/01/01	83/12/29	34.7	2.4	8.32	73
PAHRUMP, NV	83/01/03	83/12/30	14.8	4.4	7.78	68
RACHEL, NV	83/01/01	83/12/30	21.1	14.4	16.67	146
SALT LAKE CITY, UT	83/01/01	83/12/30	19.4	9.4	11.22	98
SHOSHONE, CA	83/01/01	83/12/30	15.0	9.1	11.24	98
ST. GEORGE, UT	83/01/01	83/12/30	13.1	6.1	8.63	76
STONE CABIN RNCH, NV	83/05/17	83/12/30	23.3	10.2	17.58	154
TIKABOO VALLEY, NV	83/05/16	83/12/30	19.7	10.2	15.33	134
TONOPAH, NV	83/01/01	83/12/30	25.6	15.3	17.23	151
TWIN SPRGS RNCH, NV	83/01/01	83/12/30	21.8	14.0	17.24	151

*The MAX and MIN values are obtained from the instantaneous readings.

INTERNAL EXPOSURE MONITORING

Internal exposure is caused by ingested or inhaled radionuclides that remain in the body either temporarily or for longer times because of storage in tissues. At EMSL-LV two methods are used to detect such body-burdens: whole-body counting and urinalysis.

The whole-body counting facility has been maintained at EMSL-LV since 1966 and is equipped to determine the identity and quantity of gamma-emitting radioactive materials which may have been inhaled or ingested into the body. A single thallium-activated sodium iodide crystal, 28 x 10 centimeters, is used to measure gamma radiation having energies ranging from 0.1 to 2.5 MeV. Two phoswich detectors are available and can be placed on the chest to measure low-energy radiation - for example, 17 KeV X rays from plutonium-239. The most likely mode of intake for most alpha-emitting radionuclides is inhalation, and the most important of these also emit low-energy X rays which can be detected in the lungs by the phoswich detectors.

Network Design

This activity consists of two portions, an Offsite Human Surveillance Program and a Radiological Safety Program. The design for the Offsite Human Surveillance Program is to measure radionuclide body-burdens in a representative number of families who reside in areas that were subjected to fallout during the early years of nuclear weapons tests. A few families who reside in areas not affected by such fallout were also selected for comparative study. The principal constraint to the program is the cooperation received from the people in the area of study.

The Radiological Safety Program portion requires all employees who may be exposed to radioactive materials in the course of their work to undergo a periodic whole-body count. Some DOE contractor employees are included in this.

Methods

The Offsite Human Surveillance Program was initiated in December 1970 to determine levels of radioactive nuclides in some of the families residing in communities and ranches surrounding the Nevada Test Site. Biannual counting is performed in the spring and fall. This program started with 34 families (142 individuals). In 1983, 17 of these families, 41 individuals, were still active in the program. The geographical locations of the families which participated in 1983 are shown in Figure 16.

These persons travel to the Environmental Monitoring Systems Laboratory where a whole-body count of each person is made to determine the body burden of gamma-emitting radionuclides. A urine sample is collected for analysis and a short medical history, complete blood count, thyroid profile and physical examinations are obtained on each participant at one of the visits. Results of the whole-body count are available before the families leave the facility and are discussed with the subjects. The results of the blood and urine tests are sent to the families, along with a letter of explanation from the examining physician.

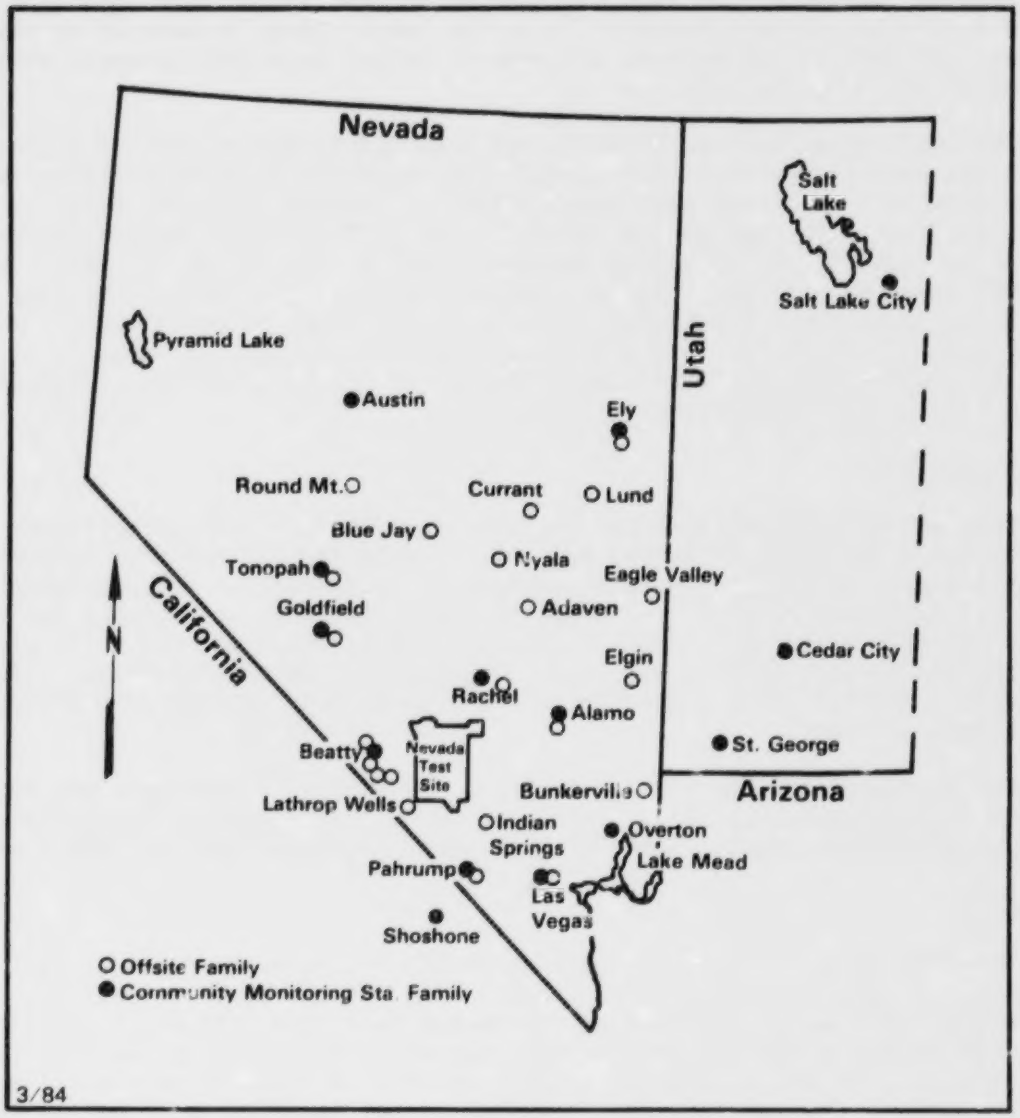

Nevada
Utah
Arizona
California
Salt Lake
Salt Lake City
Pyramid Lake
Austin
Ely
Round Mt.
Currant
Lund
Blue Jay
Nyala
Tonopah
Eagle Valley
Goldfield
Adaven
Cedar City
Elgin
Rachel
Alamo
Beatty
Nevada Test Site
St. George
Bunkerville
Lathrop Wells
Indian Springs
Overton
Lake Mead
Pahrump
Las Vegas
Shoshone
N
○ Offsite Family
● Community Monitoring Sta. Family
3/84

Figure 16. Location of families in the Human Surveillance Program.

In 1982, 15 new families were added to the surveillance program. These people are in charge of the community monitoring stations described in the following section. In 1983, three long-time residents in the offsite area, with their families, were added. As with the first group of families, each person receives a whole-body count, medical history, complete blood count, thyroid profile, etc.

In addition to these offsite families, counts are performed routinely on EPA and EG&G employees as part of health monitoring programs. Selected individuals from the general population of Las Vegas and other cities are also counted to obtain comparative data.

Results

During 1983, a total of 326 NaI(Tl) and 652 phoswich spectra were obtained from individuals, of which 154 were from persons participating in the Offsite Human Surveillance Program. Also, about 1,400 spectra for calibrations and background were generated. Cesium-137 is generally the only fission product detected though none was found in the persons counted this year. Body burdens of Cs-137 in the offsite population detected in previous years were similar to those in other U.S. residents from California to New York. All spectra collected in 1983 were representative of normal background for people and showed only natural potassium-40. No plutonium was detected in any of the phoswich spectra.

The concentration of tritium in urine samples from the offsite residents varied from 0 to 1,340 pCi/L with an average value of 167 pCi/L. Nearly all the concentrations measured were in the range of background levels measured in water and reflect only natural exposure. The source for the high values (Salt Lake City residents) is unknown but is not attributed to NTS activities. The tritium concentration in urines from EPA employees had a mean of 209 pCi/L and a range of 0 to 2170 pCi/L.

As reported in previous years, medical examination of the offsite families revealed a generally healthy population. In regard to the hematological examinations and thyroid profiles, no abnormal results were observed which could be attributed to past or present NTS testing operations. A report on data for these families, "Results of a Surveillance Program for Persons Living Around the Nevada Test Site - 1971 to 1980," was published in Health Physics (Patzer and Kaye 1982).

There were three deaths among the offsite families during 1983. One female member of an offsite family died of multiple pathology (diabetes, kidney, liver). She also was the oldest person among the families counted and was 83 years old at the time of her death. Another female, 70 years of age, died of multiple myeloma. One male, age 62, died of coronary problems.

COMMUNITY MONITORING STATIONS

To increase public knowledge about and participation in radiological surveillance activities as conducted by DOE and EPA; the DOE, through an Interagency Agreement with EPA and contracts with the Desert Research Institute

(DRI) of the University of Nevada, and the University of Utah, has established a network of 15 Community Monitoring Stations in the off-NTS areas. Each station is operated by a local resident, preferably a science teacher, who is trained in radiological surveillance methods by the University of Utah. The stations are equipped and maintained, and samples are collected and analyzed by EMSL-LV. DRI provides data interpretation to the communities involved and pays the station operators for their services.

Each station contains one of the samplers for the ASN, NGTSN and Dosimetry networks discussed earlier, plus a pressurized ion chamber (PIC) and recorder for immediate readout of external gamma exposure, and a recording barograph. All of the equipment is mounted on a stand at a convenient location in each community so the residents are aware of the surveillance and, if interested, can have ready access to the data. The station locations are those indicated in Figure 2.

The data from these stations are included in the tables in Appendix E with the other data from the appropriate networks. Table 9 contains a summary of the PIC data.

CLAIMS INVESTIGATIONS

One of the public service functions of the EMSL-LV is to investigate claims of injury allegedly due to radiation originating from NTS activities. A physician and a veterinarian, qualified by education or experience in the field of radiobiology, investigate claims of radiation injury to determine whether or not radiation exposure may be involved.

Investigation of claims from people involves determining the type of illness, from examining physicians records and diagnoses, and determining the possibility of radiation exposure through residence history and examination of historical radiation surveillance data. These investigations can be conducted by the Medical Liaison Officers Network (MLON) or by the EMSL-LV physician, depending on where the claim is made. The MLON is composed of physicians, one from each state, who are trained in radiobiology.

An MLON Conference was held at the Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, during the fall of 1983. The purpose of the meeting was to update current information on the biological effects of radiation, its diagnosis and treatment. During 1983 the MLON made 4 investigations of persons with alleged radiation claims, responded to 3 inquires and completed 4 evaluations.

The EMSL-LV veterinarian conducts similar investigations for claims of injury to domestic animals. In most cases the injuries investigated have been due to common causes such as bacterial infections or unusual events such as feeding on halogeton, a poisonous plant. In 1981 one potential claim was investigated; sudden death of two goat kids near Rachel, Nevada. By physical examination, histopathology and radionuclide analysis of samples, and from symptoms described by the owner, a diagnosis of enterotoxemia was made. Radiation exposure apparently played no role in this incident. No such claims were made in 1983.

PUBLIC INFORMATION PROGRAM

An important function of the Offsite Program has been to create and maintain, to the extent possible, public confidence that all reasonable safeguards are being employed to preserve public health and property from possible hazards resulting from nuclear testing. Much of this responsibility is carried out through personal contact with offsite residents by the radiation monitors who advise the residents of program developments and answer questions about test activities.

For any test where ground motion may be perceptible offsite, monitors visit remote locations and active mines beforehand to advise operators of possible problems. They also stand by on test day to advise of schedule changes. Mine operators are reimbursed for time lost due to these activities. After the test, monitors inform all their contacts that the test is over and whether or not any radiation was detected offsite.

To improve communications, the monitor's have been linked to a radio net used by sheepmen north of the NTS so herders and ranchers can be more readily contacted.

Town Hall type meetings were held in Panaca and Boulder City, Nevada and Hurricane, Utah for residents of those areas. In these evening meetings, the objectives and operation of the Community Monitoring Stations, their role in the Offiste Radiological Safety and nuclear testing programs, and data availability were explained. An open period for questions and free discussion was included for each meeting.

Other activities included arranging NTS tours for business and community leaders from Beatty, Death Valley, Lathrop Wells and Pahrump; for attendees at the American Water Works Assn. meeting in Las vegas, and for members of the Medical Liaison Officers Network. A tour of the offsite mining area was conducted for Blume and Associates. Talks on the Offsite Program were given to civic and professional organizations in March, May, June, August, October, and November. A complete Community Monitoring Station was exhibited at the Lincoln County Fair in Panaca and at the JC State Fair in Las Vegas, both of which occurred in August.

DOSE ASSESSMENT

Dose assessment calculations for NTS-related radioactivity are not possible because detectable levels of radioactivity from the 1983 nuclear testing program at the NTS were not observed offsite by any of the monitoring networks. However, an exposure can be calculated by using atmospheric dispersion and reported releases of radioactivity from the NTS (Table 1). This is shown below. Residual radioactivity was observed in waters from wells in other nuclear testing areas known to be contaminated during past nuclear tests at the Project Dribble Site near Hattiesburg, Mississippi; Project Gnome near Malaga, New Mexico; and at the Project Long Shot Site on Amchitka Island, Alaska.

However, the waters from these contaminated wells are not used for drinking purposes.

An estimate of exposure of an average adult in Nevada due to worldwide radioactivity can be made based on the data from the monitoring networks. The principal data are strontium-90 in milk (0.8 pCi/L) from previous atmospheric tests; krypton-85 in air (25 pCi/m^3) from power reactors and reprocessing plants; and plutonium-239 in air (6.0 aCi/m^3) from previous atmospheric tests.

Assumptions:
1) Breathing rate = 7,300 m^3/a
2) Water intake = 438 L/a, milk = 1/2 of water or 219 L/a
3) 8,766 hr/a

From DOE/EP-0023 Appendix B (DOE 1981a); first-year Dose Factors are:
1) Kr-85 (immersion) 2,200 mrem/hr per μCi/mL, whole body ($\mu Ci/mL = 10^{12}\ pCi/m^3$),
2) Sr-90 (ingestion) 45 mrem/μCi intake, whole body, and
3) Pu-239 (inhalation) 48,000 mrem/μCi to lung.

Calculated annual dose:

Kr-85: $$2{,}200\ \text{mrem/hr} \times 8{,}766\ \text{hr/a} \times \frac{25\ \text{pCi/m}^3}{10^{12}\ \text{pCi/m}^3} = 4.82 \times 10^{-4}\ \text{mrem/a}$$

Sr-90: $$45\ \text{mrem/}\mu\text{Ci} \times 10^{-6}\ \mu\text{Ci/pCi} \times 0.8\ \text{pCi/L} \times 219\ \text{L/a} = 0.0079\ \text{mrem/a}$$

Pu-239: $$4.8 \times 10^{4}\ \text{mrem/}\mu\text{Ci} \times 6.0\ \text{aCi/m}^3 \times 10^{-12}\ \mu\text{Ci/aCi} \times 7{,}300\ \text{m}^3\text{/a} = 0.002\ \text{mrem/a}$$

The highest postulated annual dose estimate to man, from the results of the 1983 Biomonitoring Program, was calculated to be 0.18 mrem. This would result from the Cs-137 content of liver from the cattle sample if an individual ate 0.5 kg per day for the whole year and if the liver tissue had the maximum measured cesium concentration all year. The highest postulated annual dose from Pu-239 was calculated to be 0.0016 mrem to the skeleton if 1/2 lb of the leafy vegetable, Lamb's Quarter, were eaten each day.

The total annual dose to the average adult in Nevada from worldwide radioactivity detected by EMSL-LV monitoring networks is then 0.19 mrem. Natural radioactivity in the body (K-40, C-14, Ra-226, etc.) causes annual internal doses ranging from 26 to 36 mrem per year (FRC 1960), and the calculated internal dose is only 1.9 percent of this 10 mrem variation.

The external exposures to Nevadans range from 42 to 140 mrem/a as measured by the TLD network. In the U.S., reported external exposures range from 63 to 200 mrem/a, depending on elevation (sea coast or Rocky Mountains) and on the natural radioactivity in the soil (NCRP 1971). The exposures measured by the TLD's compare favorably with that range as the TLD station's altitude varies from 500 to over 7,000 feet above MSL and the uranium content in soil probably also varies markedly among stations.

No radioactivity released at the NTS was measured offsite, therefore, the dose to the offsite population from these releases was calculated by using average weather data and atmospheric diffusion equations. Wind direction and speed data were available for a 12-year period as were 25,000 hourly observations of Pasquill stability class. Based on the releases shown in Table 1, the estimated population dose to the 4600 people within 80 km of CP-1 was 5×10^{-5} man-rem. The highest estimated dose was 1.8×10^{-3} mrem/yr to an individual living in Rachel, with lesser amounts to individuals in Armogosa, Beatty, Lathrop Wells and Indian Springs, Nevada.

SECTION 6

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APPENDIX A. SITE DATA

SITE DESCRIPTION

A summary of the uses of the NTS and its immediate environs is included in Section 3 of this report. More detailed data and descriptive maps are contained in this Appendix.

Location

The NTS is located in Nye County, Nevada, with its southeast corner about 90 km northwest of Las Vegas (Figure 1 in main report). It has an area of about 3,500 square km and varies from 40 to 56 km in width (east-west) and from 64 to 88 km in length (north-south). This area consists of large basins or flats about 900 to 1,200 m above mean sea level (MSL) surrounded by mountain ranges rising 1,800 to 2,300 m above MSL.

The NTS is surrounded on three sides by exclusion areas, collectively named the Nellis Air Force Range, which provide a buffer zone between the test areas and public lands. This buffer zone varies from 24 to 104 km between the test area and land that is open to the public. Depending upon wind speed and direction, from 2 to more than 6 hours will elapse before any release of airborne radioactivity could pass over public lands.

Climate

The climate of the NTS and surrounding area is variable, due to its variations in altitude and its rugged terrain. Generally, the climate is referred to as continental arid. Throughout the year, there is insufficient water to support the growth of common food crops without irrigation.

Climate may be classified by the types of vegetation indigenous to an area. According to Houghton et al. (1975), this method of classification of dry condition, developed by Doppen, is further subdivided on the basis of temperature and severity of drought. Table A-1 (Houghton et al. 1975) summarizes the characteristics of climatic types for Nevada.

According to Quiring (1968), the NTS average annual precipitation ranges from about 10 cm at the lower elevations to around 25 cm on the higher elevations. During the winter months, the plateaus may be snow-covered for a period of several days or weeks. Snow is uncommon on the flats. Temperatures vary considerably with elevation, slope, and local air currents. The average daily high (low) temperatures at the lower altitudes are around 50F (25F) in January and 95F (55F) in July, with extremes of 110F and -15F. Corresponding temperatures on the plateaus are 35F (25F) in January and 80F (65F) in July with extremes of 100F and -20F. Temperature extremes as low as -30F and higher than 115F have been observed.

TABLE A-1. CHARACTERISTICS OF CLIMATIC TYPES IN NEVADA (from Houghton et al. 1975)

	Mean Temperature °C (°F)		Annual Precipitation cm (inches)			
Climate Type	Winter	Summer	Total*	Snowfall	Dominant Vegetation	Percent of Area
Alpine tundra	-18° to -9° (0° to 15°)	4° to 10° (40° to 50°)	38 to 114 (15 to 45)	Medium to heavy	Alpine meadows	--
Humid continental	-12° to -1° (10° to 30°)	10° to 21° (50° to 70°)	64 to 114 (25 to 45)	Heavy	Pine-fir forest	1
Subhumid continental	-12° to -1° (10° to 30°)	10° to 21° (50° to 70°)	30 to 64 (12 to 25)	Moderate	Pine or scrub woodland	15
Mid-latitude steppe	-7° to 4° (20° to 40°)	18° to 27° (65° to 80°)	15 to 38 (6 to 15)	Light to moderate	Sagebrush, grass, scrub	57
Mid-latitude desert	-7° to 4° (20° to 40°)	18° to 27° (65° to 80°)	8 to 20 (3 to 8)	Light	Greasewood, shadscale	20
Low-latitude desert	-4° to 10° (40° to 50°)	27° to 32° (80° to 90°)	5 to 25 (2 to 10)	Negligible	Creosote bush	7

*Limits of annual precipitation overlap because of variations in temperature which affect the water balance.

The wind direction, as measured on a 30-m tower at an observation station about 9 km NNW of Yucca Lake, is predominantly northerly except during the months of May through August when winds from the south-southwest predominate (Quiring 1968). Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours of most months. During the winter months southerly winds have only a slight edge over northerly winds for a few hours during the warmest part of the day. These wind patterns may be quite different at other locations on the NTS because of local terrain effects and differences in elevation.

Geology and Hydrology

Two major hydrologic systems shown in Figure A-1 exist on the NTS (ERDA 1977). Ground water in the northwestern part of the NTS or in the Pahute Mesa area has been reported to flow at a rate of 2 m to 180 m per year to the south and southwest toward the Ash Meadows Discharge Area in the Amargosa Desert. It is estimated that the ground water to the east of the NTS moves from north to south at a rate of not less than 2 m nor greater than 220 m per year. Carbon-14 analyses of this eastern ground water indicate that the lower velocity is nearer the true value. At Mercury Valley in the extreme southern part of the NTS, the eastern ground water flow shifts southwestward toward the Ash Meadows Discharge Area.

Land Use of NTS Environs

Figure A-2 is a map of the off-NTS area showing a wide variety of land uses, such as farming, mining, grazing, camping, fishing, and hunting within a 300-km radius of the NTS. For example, west of the NTS, elevations range from 85 m below MSL in Death Valley to 4,420 m above MSL in the Sierra Nevada Range. Parts of two major agricultural valleys (the Owens and San Joaquin) are included. The areas south of the NTS are more uniform since the Mojave Desert ecosystem (mid-latitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS are primarily mid-latitude steppe with some of the older river valleys, such as the Virgin River Valley and Moapa Valley, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly to the northeast. The area north of the NTS is also mid-latitude steppe, where the major agricultural activity is grazing of cattle and sheep. Minor agriculture, primarily the growing of alfalfa hay, is found in this portion of the State within 300 km of the NTS Control Point-1 (CP-1). Many of the residents grow or have access to locally grown fruits and vegetables.

Many recreational areas, in all directions around the NTS (Figure A-2) are used for such activities as hunting, fishing, and camping. In general, the camping and fishing sites to the northwest, north, and northeast of the NTS are utilized throughout the year except for the winter months. Camping and fishing locations to the southeast, south, and southwest are utilized throughout the year. The hunting season is from September through January.

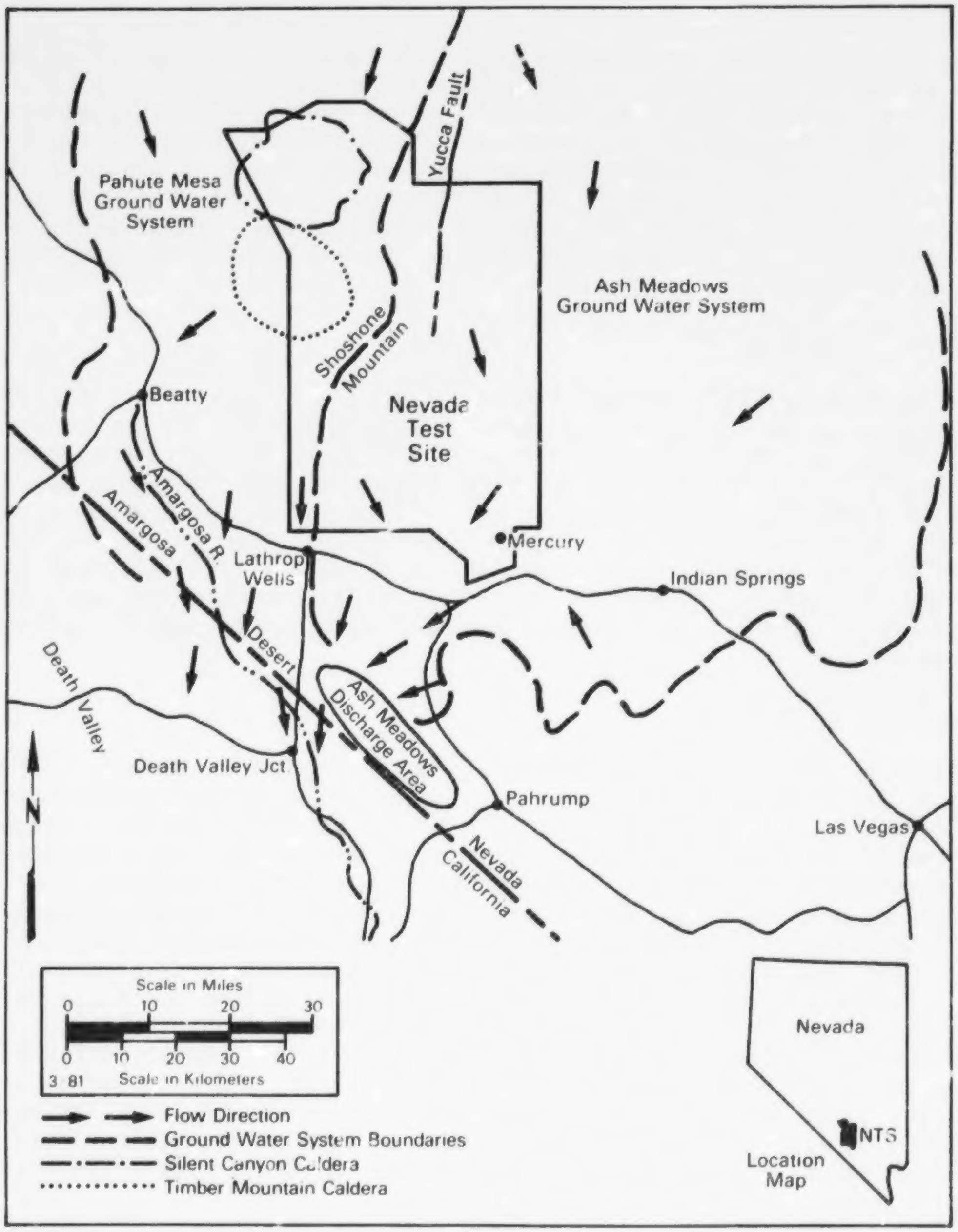
Yucca Fault
Pahute Mesa
Ground Water
System
Ash Meadows
Ground Water System
Shoshone
Mountain
Nevada
Test
Site
Beatty
Amargosa R.
Amargosa
Desert
Lathrop
Wells
Mercury
Indian Springs
Death
Valley
Ash Meadows
Discharge Area
Death Valley Jct.
Pahrump
Las Vegas
Nevada
California
N
Scale in Miles
0
10
20
30
0
10
20
30
40
3 81
Scale in Kilometers
Flow Direction
Ground Water System Boundaries
Silent Canyon Caldera
Timber Mountain Caldera
Nevada
NTS
Location
Map

Figure A-1. Groundwater flow systems around the Nevada Test Site.

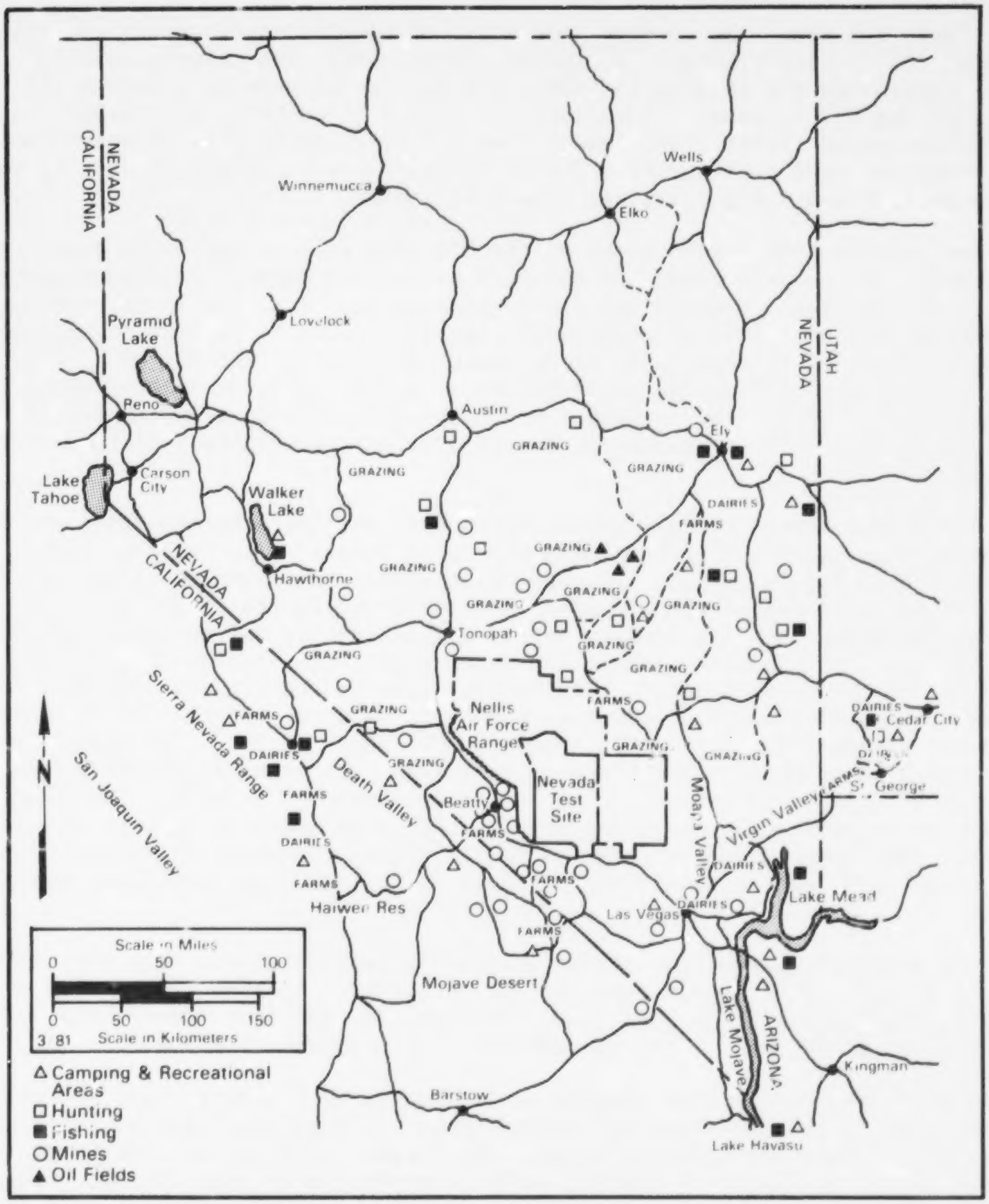
NEVADA
CALIFORNIA
UTAH
NEVADA
ARIZONA
Winnemucca
Wells
Elko
Lovelock
Pyramid Lake
Reno
Austin
Ely
Lake Tahoe
Carson City
Walker Lake
Hawthorne
Tonopah
GRAZING
DAIRIES
FARMS
Nellis Air Force Range
Nevada Test Site
Beatty
Death Valley
Sierra Nevada Range
San Joaquin Valley
Haiwee Res
Mojave Desert
Las Vegas
Moapa Valley
Virgin Valley
Cedar City
St. George
Lake Mead
Lake Mojave
Kingman
Barstow
Lake Havasu
N
Scale in Miles
0
50
100
0
50
100
150
Scale in Kilometers
3 81
△ Camping & Recreational Areas
□ Hunting
■ Fishing
○ Mines
▲ Oil Fields

Figure A-2. General land use within 300 km of the Nevada Test Site.

Population Distribution

Figure A-3 shows the current population of counties surrounding the NTS based on 1980 census figures. Excluding Clark County, the major population center (approximately 462,000 in 1980), the population density within a 150 km radius of the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for Nevada in 1980 was 2.8 persons per square kilometer.

The offsite area within 80 km of the NTS (the area in which the dose commitment must be determined for the purpose of this report) is predominantly rural. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of about 3,900, is located about 72 km south-southwest of the NTS CP-1. The Amargosa Farm Area, which has a population of about 1,600, is located about 50 km southwest of CP-1. The largest town in the near-offsite area is Beatty, which has a population of about 800 and is located approximately 65 km to the west of CP-1.

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service (1980) estimates that the population within the Monument boundaries ranges from a minimum of 900 permanent residents during the summer months to as many as 5,000 tourists and campers on any particular day during the major holiday periods in the winter months, and as many as 30,000 during "Death Valley Days" in the month of November. The largest town and contiguous populated area (about 40 square miles) in the Mojave Desert is Barstow, located 265 km south-southwest of the NTS, with a 1983 population of about 36,000. The next largest populated area is the Ridgecrest-China Lake area, which has a current population of about 25,000 and is located about 190 km southwest of the NTS. The Owens Valley, where numerous small towns are located, lies about 50 km west of Death Valley. The largest town in Owens Valley is Bishop, located 225 km west-northwest of the NTS, with a population of about 5,300 including contiguous populated areas.

The extreme southwestern region of Utah is more developed than the adjacent part of Nevada. The largest community is St. George, located 220 km east of the NTS, with a population of 11,300. The next largest town, Cedar City, with a population of 10,900, is located 280 km east northeast of the NTS.

The extreme northwestern region of Arizona is mostly range land except for that portion in the Lake Mead Recreation Area. In addition, several small communities lie along the Colorado River. The largest town in the area is Kingman, located 280 km southeast of the NTS, with a population of about 9,200. Figures A-4 through A-7 show the domestic animal populations in the counties near the NTS.

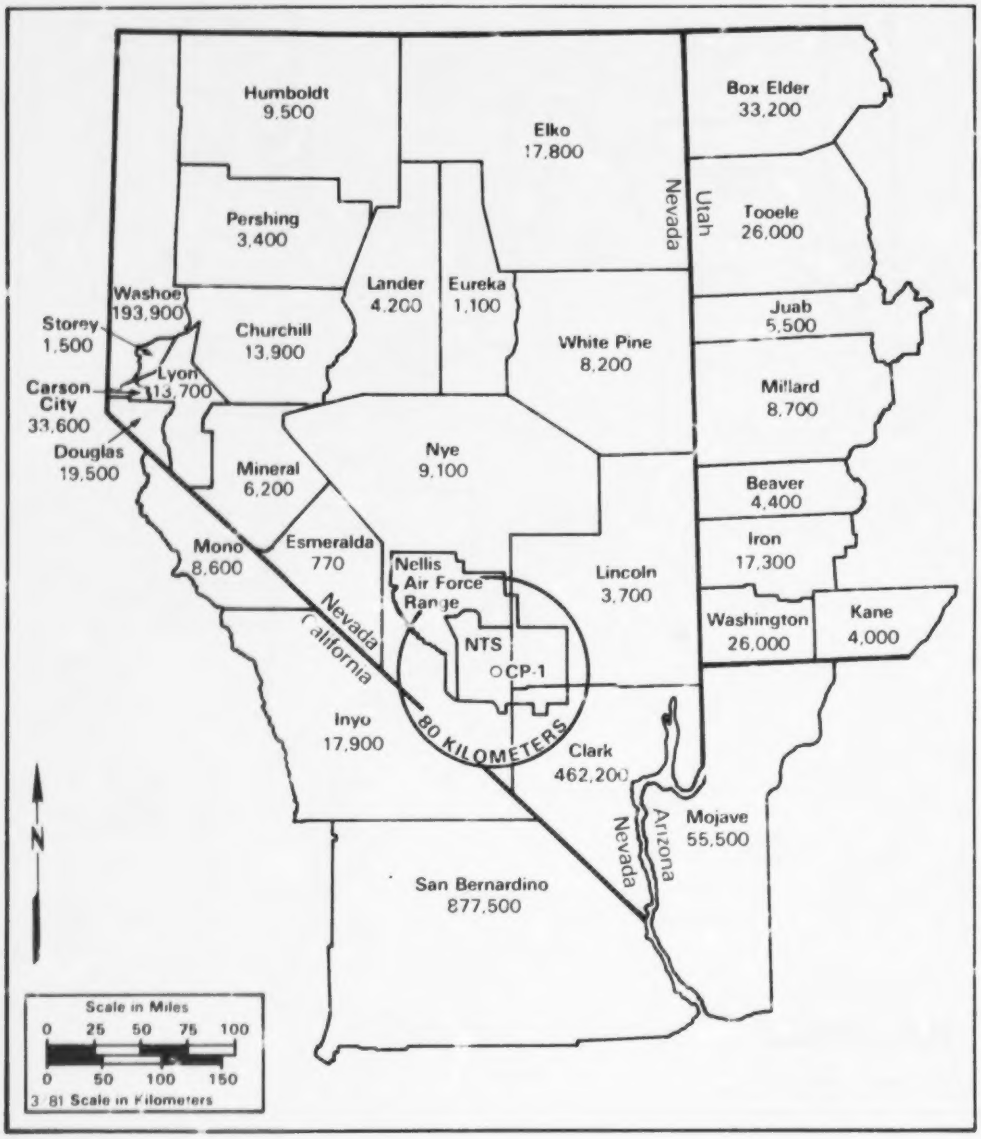
Humboldt
9,500
Elko
17,800
Box Elder
33,200
Pershing
3,400
Nevada
Utah
Tooele
26,000
Lander
4,200
Eureka
1,100
Washoe
193,900
Juab
5,500
Storey
1,500
Churchill
13,900
White Pine
8,200
Lyon
13,700
Carson City
33,600
Millard
8,700
Douglas
19,500
Nye
9,100
Mineral
6,200
Beaver
4,400
Iron
17,300
Mono
8,600
Esmeralda
770
Nellis Air Force Range
Lincoln
3,700
Nevada
California
Washington
26,000
Kane
4,000
NTS
CP-1
Inyo
17,900
80 KILOMETERS
Clark
462,200
Mojave
55,500
Nevada
Arizona
N
San Bernardino
877,500
Scale in Miles
0
25
50
75
100
0
50
100
150
3-81 Scale in Kilometers

Figure A-3. Population of Arizona, California, Nevada, and Utah counties near the Nevada Test site (1980).

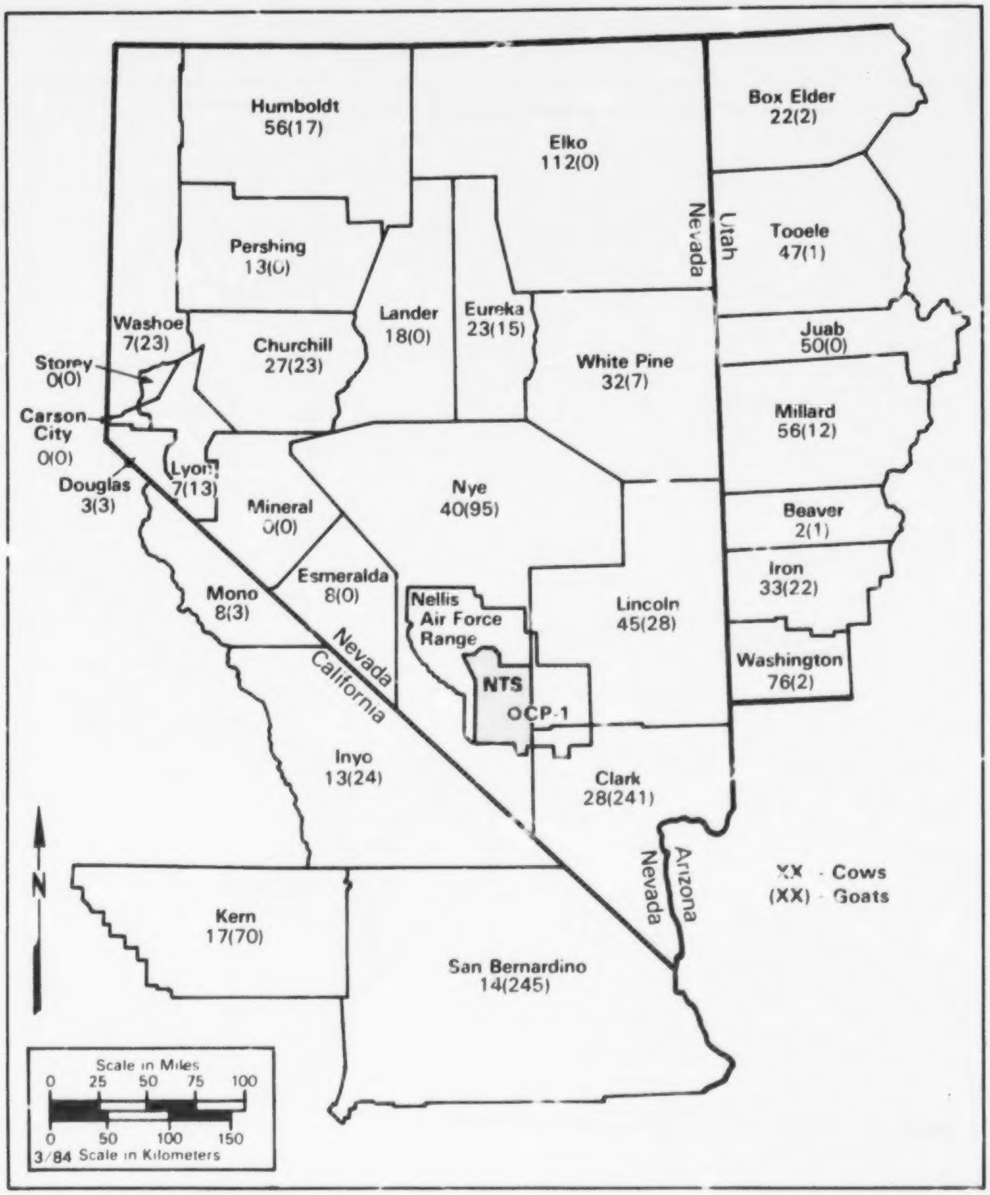
Humboldt 56(17)
Elko 112(0)
Box Elder 22(2)
Pershing 13(0)
Nevada
Utah
Tooele 47(1)
Lander 18(0)
Eureka 23(15)
Washoe 7(23)
Churchill 27(23)
Juab 50(0)
White Pine 32(7)
Storey 0(0)
Carson City 0(0)
Millard 56(12)
Douglas 3(3)
Lyon 7(13)
Mineral 0(0)
Nye 40(95)
Beaver 2(1)
Iron 33(22)
Esmeralda 8(0)
Mono 8(3)
Nellis Air Force Range
Lincoln 45(28)
Nevada
California
Washington 76(2)
NTS
OCP-1
Inyo 13(24)
Clark 28(241)
N
Nevada
Arizona
XX - Cows
(XX) - Goats
Kern 17(70)
San Bernardino 14(245)
Scale in Miles
0 25 50 75 100
0 50 100 150
3/84 Scale in Kilometers

Figure A-4. Distribution of family milk cows and goats, by county (1983).

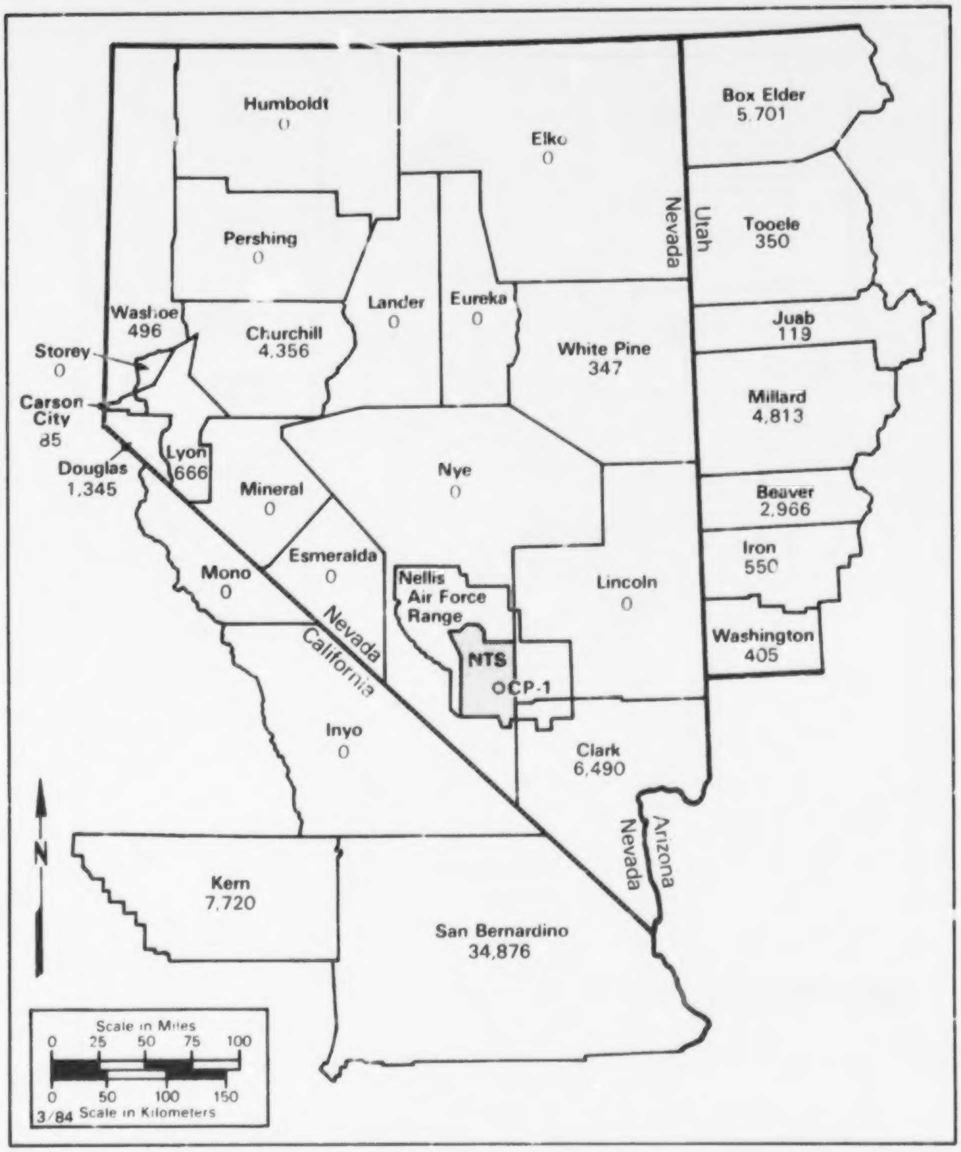
Humboldt
0
Elko
0
Box Elder
5,701
Pershing
0
Nevada
Utah
Tooele
350
Washoe
496
Lander
0
Eureka
0
Juab
119
Churchill
4,356
White Pine
347
Storey
0
Millard
4,813
Carson City
85
Lyon
666
Nye
0
Douglas
1,345
Mineral
0
Beaver
2,966
Iron
550
Esmeralda
0
Mono
0
Lincoln
0
Nellis Air Force Range
Washington
405
Nevada
California
NTS
OCP-1
Inyo
0
Clark
6,490
N
Arizona
Nevada
Kern
7,720
San Bernardino
34,876
Scale in Miles
0 25 50 75 100
0 50 100 150
3/84 Scale in Kilometers

Figure A-5. Distribution of dairy cows, by county (1983).

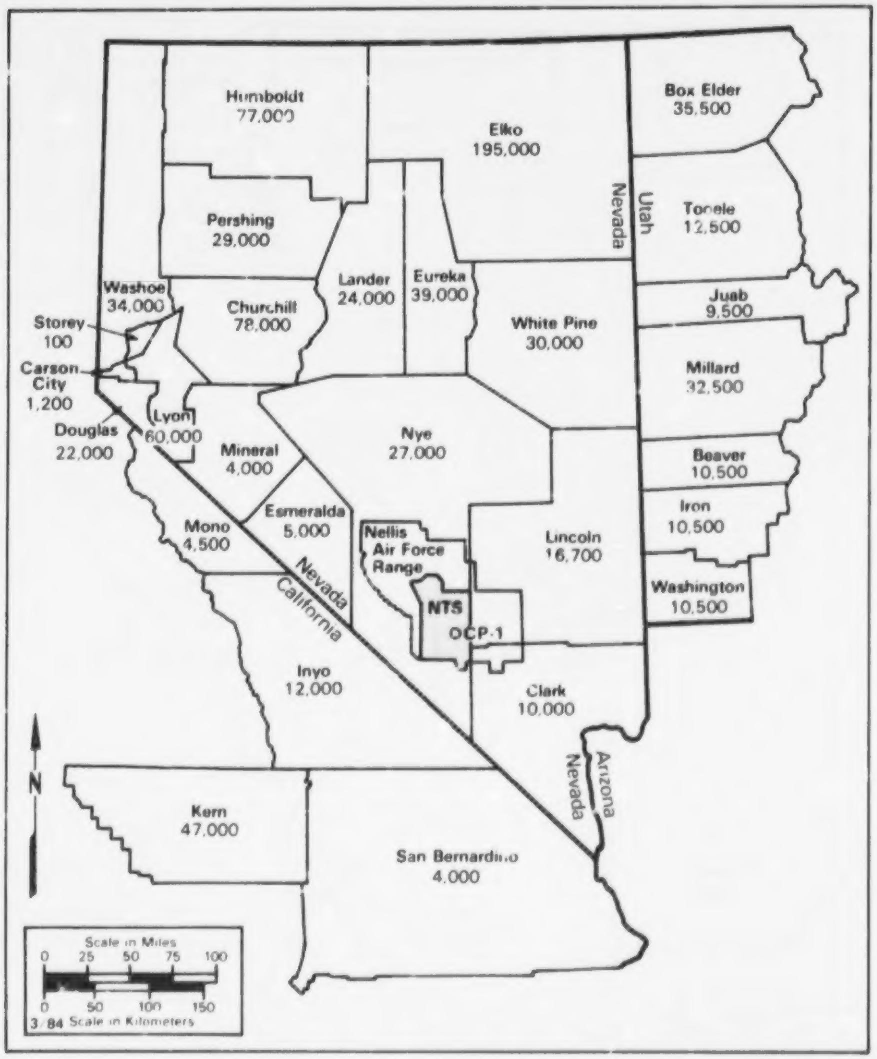
Humboldt 77,000
Elko 195,000
Box Elder 35,500
Pershing 29,000
Nevada
Utah
Tooele 12,500
Washoe 34,000
Storey 100
Carson City 1,200
Churchill 78,000
Lander 24,000
Eureka 39,000
Juab 9,500
White Pine 30,000
Millard 32,500
Douglas 22,000
Lyon 60,000
Mineral 4,000
Nye 27,000
Beaver 10,500
Iron 10,500
Mono 4,500
Esmeralda 5,000
Nellis Air Force Range
Lincoln 16,700
Washington 10,500
Nevada
California
NTS
OCP-1
Inyo 12,000
Clark 10,000
N
Arizona
Nevada
Kern 47,000
San Bernardino 4,000
Scale in Miles
0 25 50 75 100
0 50 100 150
3-84 Scale in Kilometers

Figure A-6. Distribution of beef cattle, by county, 1983.

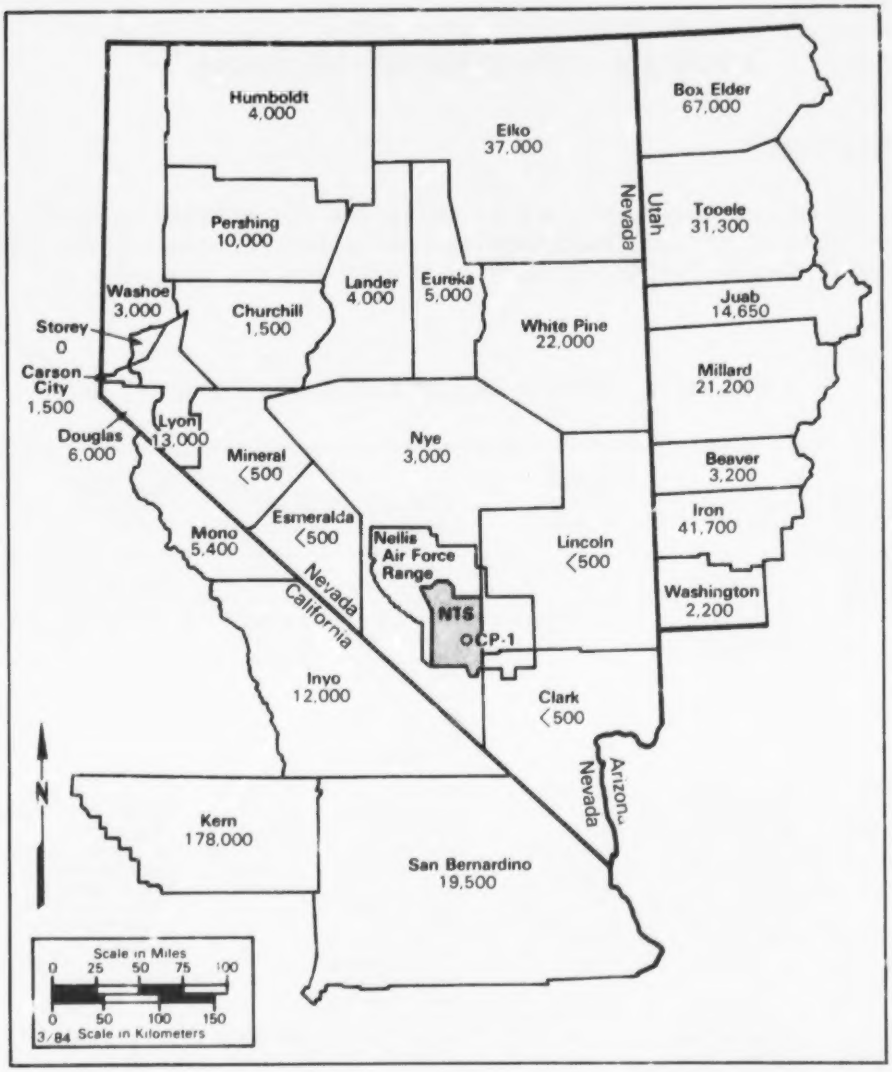
Humboldt
4,000
Elko
37,000
Box Elder
67,000
Pershing
10,000
Nevada
Utah
Tooele
31,300
Washoe
3,000
Storey
0
Carson City
1,500
Churchill
1,500
Lander
4,000
Eureka
5,000
White Pine
22,000
Juab
14,650
Millard
21,200
Douglas
6,000
Lyon
13,000
Mineral
<500
Nye
3,000
Beaver
3,200
Esmeralda
<500
Iron
41,700
Mono
5,400
Nellis
Air Force
Range
NTS
CP-1
Lincoln
<500
Washington
2,200
Nevada
California
Inyo
12,000
Clark
<500
Arizona
Nevada
N
Kern
178,000
San Bernardino
19,500
Scale in Miles
0
25
50
75
100
0
50
100
150
Scale in Kilometers
3/84

Figure A-7. Distribution of sheep, by county, 1983.

APPENDIX B. SAMPLE ANALYSIS PROCEDURES

ANALYTICAL PROCEDURES

The procedures for analyzing samples collected for offsite surveillance are described by Johns et al. in "Radiochemical Analytical Procedures for Analyses of Environmental Samples" (EMSL-LV-0539-17, 1979) and are summarized in Table B-1.

TABLE B-1. SUMMARY OF ANALYTICAL PROCEDURES

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit*
NaI(Tl) Gamma Spectrometry**	NaI detector calibrated at 10 keV per channel (0.05-2.0 MeV range).	10 min. for air charcoal cartridges	Radionuclide concentrations quantified from gamma spectral data by computer using a least squares technique.	120-300 m^3 for air charcoal cartridge samples.	0.04 pCi/m^3.
IG Ge(Li) Gamma Spectrometry**	IG or Ge(Li) detector calibrated at 0.5 keV/channel (0.04 to 2 MeV range) individual detector efficiencies ranging from 15% to 35%.	Individual air filters, 30 min; air filter composites, 1200 min. 100 min for milk, water, suspended solids.	Radionuclide concentration quantified from gamma spectral data by on-line computer program. Radionuclides in air filter composite samples are identified only.	120-300 m^3 for air filters; 3-1/2 liters for milk and water.	For routine milk and water generally, 5 pCi/L for most common fallout radionuclides in a simple spectrum. Filters for LTHMP suspended solids, 6 pCi/L. Air filters, 0.04 pCi/m^3.
Gross beta on air filters	Low-level end window, gas flow proportional counter with a 12.7 cm diameter window (80 $\mu g/cm^2$)	30	Samples are counted after decay of naturally-occuring radionuclides and, if necessary, extrapolated to mid-point of collection in accordance with $t^{-1.2}$ decay or an experimentally-derived decay.	120-300 m^3	0.5 pCi/sample.

(continued)

TABLE B-1. (Continued)

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit*
Sr-89-90	Low-background thin-window, gas-flow proportional counter.	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous solution of equations.	1.0 liter for milk or water. 0.1-1 kg for tissue.	Sr-89 = 5 pCi/L Sr-90 = 2 pCi/L.
H-3	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	4 ml for water	400 pCi/L.
H-3 Enrichment (Long-Term Hydrological Samples)	Automatic scintillation counter with output printer.	200	Sample concentrated by electrolysis followed by distillation.	250 ml for water	10 pCi/L.
Pu-238,239	Alpha spectrometer with 450 mm, 300-μm depletion depth, silicon surface barrier detectors operated in vacuum chambers.	1000-1400	Water sample or acid-digested filter or tissue samples separated by ion exchange, electro-plated on stainless steel planchet.	1.0 liter for water; 0.1-1 kg for tissue; 5,000-10,000 m^3 for air.	Pu-238 = 0.08 pCi/L Pu-239 = 0.04 pCi/L for water. For tissue samples, 0.04 pCi per total sample for all isotopes; 5-10 aCi/m^3 for plutonium on air filters.
Kr-85, Xe-133, Xe-135	Automatic liquid scintillation counter with output printer.	200	Separation by gas chromatography; disolved in toluene "cocktail" for counting	0.4-1.0 m^3 for air	Kr-85, Xe-133, Xe-135 = 4 pCi/m^3.

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*The detection limit for all samples received after January 1, 1978 is defined as 3.29 sigma where sigma equals the counting error of the sample and Type I error = Type II error = 5 percent. (J. P. Corley, D. H. Denham, R. E. Jaquish, D. E. Michels, A. R. Olsen, D. A. Waite, A Guide for Environmental Radiological Surveillance at U.S. Dept. of Energy Installations, July 1981, Office of Operational Safety Report DOE/EP-0023, U.S. DOE, Washington, D. C.)

**Gamma Spectrometry performed by thallium activated sodium iodide (NaI(Tl)), intrinsic germanium (IG), or lithium-drifted germanium diode (Ge(Li)) detectors.

APPENDIX C. QUALITY ASSURANCE PROCEDURES

PRECISION OF ANALYSIS

The duplicate sampling program was initiated for the purpose of routinely assessing the errors due to sampling, analysis, and counting of samples obtained from the surveillance networks maintained by the EMSL-LV.

The program consists of the analysis of duplicate or replicate samples from the ASN, the NGTSN, the LTHMP, and the Dosimetry Network. As the radioactivity concentration in samples collected from the LTHMP and the MSN are below detection levels, most duplicate samples for these networks are prepared from spiked solutions. The NGTSN samples are generally split for analysis.

At least 30 duplicate samples from each network are normally collected and analyzed over the report period. Since three TLD cards consisting of two TLD chips each are used at each station of the Dosimetry Network, no additional samples were necessary. Table C-1 summarizes the sampling information for each surveillance network.

To estimate the precision of a methodology, the standard deviation of replicate results is needed. Thus, for example, the variance, s^2, of each set

TABLE C-1. SAMPLES AND ANALYSES FOR DUPLICATE SAMPLING PROGRAM, 1983

Surveillance Network	Number of Sampling Locations	Samples Collected Per Year	Sets of Duplicate Samples Collected	Number Per Set	Sample Analysis
ASN	121	4,965	616	2	Gross beta, Spectrometry
NGTSN	16	824 (NG) 829 (H3)	47 57	2	Kr-85, H-3, H_2O, HTO
Dosimetry	86	344	344	4-6	Effective dose from gamma
MSN	27	98	25	2	K-40, Sr-89, Sr-90
LTHMP	134	254	34	2	H-3

of replicate TLD results (n=6) was estimated from the results by the standard expression,

$$s^2 = \sum_{i=1}^{k} (x_i - \overline{x})^2 / (k - 1)$$

where k = number of sets of replicates.

Since duplicate samples were collected for all other sample types, the variances, s^2, for these types were calculated from $s^2 = (0.886R)^2$, where R is the absolute difference between the duplicate sample results. For small sample sizes, this estimate of the variance is statistically efficient* and certainly more convenient to calculate than the standard expression. The standard deviation is obtained by taking the square root.

The principle that the variances of random samples collected from a normal population follow a chi-square distribution (X^2) was then used to estimate the expected population standard deviation for each type of sample analysis. The expression used is as follows:**

$$s = \left[\sum_{i=1}^{k} (n_i - 1) s_i^2 / \sum_{i=1}^{k} (n_i - 1) \right]^{1/2}$$

where n_i-1 = the degrees of freedom for n samples collected for the ith replicate sample

s_i^2 = the expected variance of the ith replicate sample

s = the best estimate of sample standard deviation derived from the variance estimates of all replicate samples (the expected value of s^2 is σ^2).

For expressing the precision of measurement in common units, the coefficient of variation ($s/\overline{x}$) was calculated for each sample type. These are displayed in Table C-2 for those analyses for which there were adequate data.

To estimate the precision of counting, approximately 10 percent of all samples are counted a second time. These are unknown to the analyst. Since all such replicate counting gave results within the counting error, the precision data in Table C-2 represents errors principally in analysis.

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*Snedecor, G. W., and W. G. Cochran. Statistical Methods. The Iowa State University Press, Ames, Iowa. 6th Ed. 1967. pp. 39-47.

**Freund, J. E. Mathematical Statistics. Prentice Hall, Englewood, New Jersey. 1962. pp 189-235.

TABLE C-2. SAMPLING AND ANALYTICAL PRECISION, 1983

Surveillance Network	Analysis	Sets of Replicate Samples Evaluated	Coefficient of Variation (%)
ASN	Gross β	18	20
	Be-7 (1982)	9	37
NGTSN	Kr-85	18	14
	HTO	*	24
	H_2O	48	23
Dosimetry	(TLD)	337	3.9
SMSN	K-40	33	10
	Sr-89	20	12
	Sr-90	25	6
LTHMP	H-3 (conv. 1983)	52	8
	H-3 (enrich. 1983)	23	18

*Estimate of precision was calculated from the errors in the H-3 conventional analysis and the measurement of atmospheric moisture (H_2O).

ACCURACY OF ANALYSIS

Data from the analysis of intercomparison samples are statistically analyzed and compared to known values and values obtained from other participating laboratories. A summary of the statistical analysis is given in Table C-3, which compares the mean of three replicate analyses with the known value. The normalized deviation is a measure of the accuracy of the analysis when compared to the known concentration. The determination of this parameter is explained in detail separately (Jarvis and Siu). If the value of this parameter (in multiples of standard normal deviate, unitless) lies between control limits of -3 and +3, the precision or accuracy of the analysis is within normal statistical variation. However, if the parameters exceed these limits, one must suspect that there is some cause other than normal statistical variations that contributed to the difference between the measured values and the known value. As shown by this table, all analyses were within the control limit.

TABLE C-3. 1983 QUALITY ASSURANCE INTERCOMPARISON RESULTS

Analysis	Month	Mean of Replicate Analyses (pCi/L)	Known Value (pCi/L)	Normalized Deviation from: Known Conc.
H-3 in water	Feb	2479	2560	-0.4
	Apr	3274	3330	-0.3
	Jun	1391	1529	-0.7
	Aug	1713	1836	-0.6
	Oct	1135	1210	-0.4
	Dec	2187	2389	-1.0
H-3 in urine	Mar	1977	2470	-2.4
	Jun	1508	1589	-0.4
	Nov	820	1008	-1.0
Cr-51 in water	Feb	50	45	1.6
	Jun	<60	60	-
	Oct	46	51	-1.8
Co-60 in water	Feb	22	22	0.1
	Jun	13	13	0.0
	Oct	18	19	-0.5
Zn-65 in water	Feb	20	21	-0.2
	Jun	34	36	-0.7
	Oct	43	40	1.2
Ru-106 in water	Feb	41	48	-2.4
	Jun	<75	40	-
	Oct	45	52	-2.5
I-131 in water	Apr	23.7	26.8	-0.9
	Aug	14	14	0.3
Cs-134 in water	Feb	18	20	-0.8
	Jun	40	47	-2.4
	Oct	15	15	-0.1
Cs-137 in water	Feb	18	19	-0.3
	Jun	25	26	-0.2
	Oct	22	22	0.1
Sr-89 in milk	Feb	40.0	37.4	0.9
	Jun	27	25	0.8
	Oct	21	15	2.2

(continued)

TABLE C-3. (Continued)

Analysis	Month	Mean of Replicate Analyses (pCi/L)	Known Value (pCi/L)	Normalized Deviation from: Known Conc.
Sr-90 in milk	Feb	19.0	17.8	1.4
	Jun	16	16	-0.3
	Oct	18	14	4.2
I-131 in milk	Feb	53.3	54.5	-0.3
	Jun	26	30	-1.1
	Oct	36	40	-1.2
Cs-137 in milk	Feb	24.3	25.6	-0.4
	Jun	45	47	-0.6
	Oct	33	33	-0.1
Cs-137 in air filters (pCi/filter)	Mar	34	27	2.4
	Aug	18	15	0.9

To measure the performance of the contractor laboratory for analysis of animal and vegetable samples, a known amount of activity was added to several samples. The reported activity is compared to the known amount in Table C-4. The average bias for Sr-90 was -28% and for Pu-239 was 0.7%.

QUALITY ASSURANCE-DOSIMETRY

Radioanalytical counting systems and TLD systems are calibrated using radionuclide standards that are traceable to the National Bureau of Standards (NBS). These standards are obtained from the Quality Assurance Division at EMSL-LV or from NBS. Each standard source used for TLD calibrations is periodically checked for accuracy in accordance with procedures traceable to NBS.

To determine accuracy of the data obtained from the TLD systems, dosimeters are submitted to the international intercomparison of environmental dosimeters. Dosimeters were submitted to the Sixth International Intercomparison in July 1981 (Table C-5). All TLD measurements are performed in conformance with standards proposed by the American National Standards Institute (ANSI 1975).

TABLE C-4. QUALITY ASSURANCE RESULTS FOR THE BIOENVIRONMENTAL PROGRAM

Sample Type and Shipment Number	Nuclide	Activity Added (pCi/kg*) Liver (pCi/g ash) Bone	Activity Reported (pCi/kg*) Liver (pCi/g ash) Bone	% Bias+
Bone Ash				
Ash 1	239Pu	0	0.00	-
45	90Sr	0	1.5	-
Ash 2	239Pu	0	-0.001	-
45	90Sr	0	1.7	-
Ash 3	239Pu	0.16	0.16	0
45	90Sr	14.8	9.22	-42
Ash 4	239Pu	0.13	0.17	31
45	90Sr	27.4	14.1	-49
Ash 1	239Pu	0	0.00052**	-
51	90Sr	0	1.71	-
Ash 2	239Pu	5.15	5.16	0.2
51	90Sr	9.96	9.85	-4.5
ASL 3	239Pu	6.24	5.96	-4.5
51	90Sr	12.1	11.8	-16
ASL 4	239Pu	5.43	5.40	-0.6
51	90Sr	10.51	11.0	-12
Liver 1	239Pu	0	0.11**	-
51				-
Liver 2	239Pu	4.64	4.18	-12
51				
Liver 3	239Pu	4.71	4.34	-10
51				
Liver 4	239Pu	5.04	4.92	-4.6
Duplicate Samples				
Bov-2-Liver 51	239Pu	0	0.71*-0.75**	
Bov-2-Liver 51	239Pu	0	0.44*-0.12	

* Wet weight

+ Bias (B) = Recovery -1; where recovery is $\frac{x_1}{u}$

and x_1 = net activity reported

u = activity added

Precision (C_v) = $2 \frac{(x_1 - x_2}{x_1 + x_2} \times \frac{1}{1.128}$ where x_1 = first value

x_2 = second value

**Counting error exceeds reported activity

TABLE C-5. SUMMARY RESULTS OF THE SIXTH INTERNATIONAL INTERCOMPARISON OF ENVIRONMENTAL DOSIMETERS

Quantity	Mean	Standard Deviation	Comments
Summary of Laboratory Results (mR):			
EMSL-LV Dosimeters	146	11	EMSL-LV results 2% lower than all dosimeters and 8% lower than the calculated exposure.
All Dosimeters	149	21	
Calculated Exposure	158	8	
Summary of Field (Pre-irradiated) Results (mR):			
EMSL-LV Dosimeters	191	14	EMSL-LV results 0% lower than all dosimeters and 5% lower than the calculated exposure.
All Dosimeters	191	30	
Calculated Exposure	202	10	
Summary of Field Results (mR):			
EMSL-LV Dosimeters	43.1	3.2	EMSL-LV results 4.2% lower than all dosimeters and 0.9% lower than the calculated exposure.
All Dosimeters	45.0	16.4	
Calculated Exposure	43.5	2.2	

APPENDIX D. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

DOE ANNUAL DOSE COMMITMENT

The annual dose commitment tabulated below is from "Basic Radiation Protection Criteria" in NCRP Report No. 39.

Type of Exposure	Dose Limit to Individuals in Uncontrolled Area at Points of Maximum Probable Exposure (rem)	Dose Limit to Suitable Sample of the Exposed Population in an Uncontrolled Area (rem)
Whole body, gonads, or bone marrow	0.5	0.17
Other organs	1.5	0.5

DOE CONCENTRATION GUIDES

The concentration guides (CG's) in Table D-1 are from the DOE Order 5480.1, Chapter XI, "Requirements for Radiation Protection." All values are annual average concentrations. The Concentration Guides are based on a suitable sample of the exposed population in an uncontrolled area. The final column lists the Minimum Detectable Concentration from Appendix B as a percent of the CG.

EPA CONCENTRATION GUIDE

In 1976 the Environmental Protection Agency published concentration guides for drinking water (Part 141, CFR 40, Amended) which included 20,000 pCi/L for tritium. This concentration would result in 4 mrem/a to an individual from continuous exposure.

TABLE D-1. DOE CONCENTRATION GUIDES

Network or Program	Sampling Medium	Radio-nuclide	CG	MDC as % of CG
			(pCi/m^3)	
Air Surveillance Network	air	Be-7	1.3×10^4	3.1×10^{-4}
		Zr-95	3.3×10^2	1.2×10^{-2}
		Nb-95	1.0×10^3	4.0×10^{-3}
		Mo-99	2.3×10^3	1.7×10^{-3}
		Ru-103	1.0×10^3	4.0×10^{-3}
		I-131	3.3×10^1	1.2×10^{-1}
		Te-132	1.3×10^3	3.1×10^{-3}
		Cs-137	1.7×10^2	2.4×10^{-2}
		Ba-140	3.3×10^2	1.2×10^{-2}
		La-140	1.3×10^3	3.1×10^{-3}
		Ce-141	1.7×10^3	2.4×10^{-3}
		Ce-144	6.7×10^1	6.0×10^{-2}
		Pu-239	2.0×10^{-2}	5.0×10^{-2}
Noble Gas and Tritium Surveillance Network	air	Kr-85	1.0×10^5	4.0×10^{-3}
		H-3	6.7×10^4	6.0×10^{-1}
		Xe-133	1.0×10^5	4.0×10^{-3}
		Xe-135	3.3×10^4	1.2×10^{-2}
			(pCi/L)	
Long-Term Hydrological Program	water	H-3	1.0×10^6	1.0×10^{-3}
		Sr-89	1.0×10^3	5.0×10^{-1}
		Sr-90	1.0×10^2	2.0×10^{-0}
		Cs-137	6.7×10^3	1.5×10^{-1}
		Ra-226	1.0×10^1	
		U-234	1.3×10^3	
		U-235	1.3×10^3	
		U-238*	2.0×10^2	
		Pu-238	1.7×10^3	4.7×10^{-3}
		Pu-239	1.7×10^3	2.4×10^{-3}
Milk Surveillance Networks	milk	H-3	1.0×10^6	1.0×10^{-3}
		Cs-137	6.7×10^3	1.5×10^{-1}
		Sr-89	1.0×10^3	5.0×10^{-1}
		Sr-90	1.0×10^2	2.0×10^{-0}

*Concentration based on chemical toxicity.

APPENDIX E. DATA SUMMARY FOR THE MONITORING NETWORKS

TABLE E-1. 1983 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK CONTINUOUSLY OPERATING STATIONS

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG*
DEATH VALLEY JCT CALIF	23.0/364.0	7BE	0.51	0.29	0.025
FURNACE CREEK CALIF	21.8/360.4	7BE	0.62	0.25	0.022
SHOSHONE CALIF	9.5/350.4	7BE	0.66	0.28	0.012
ALAMO NEV	15.6/352.1	7BE	0.69	0.36	0.021
AUSTIN NEV	6.0/314.8	7BE	0.52	0.23	0.0072
BEATTY NEV	16.9/355.3	7BE	0.58	0.30	0.018
STONE CABIN RANCH NEV	5.9/357.0	7BE	0.50	0.38	0.0072
CURRANT NEV - BLUE EAGLE RANCH	15.5/331.1	7BE	0.76	0.43	0.026
ELY NEV	3.0/350.0	7BE	0.22	0.22	0.0019
GOLDFIELD NEV	11.2/355.8	7BE	0.67	0.50	0.019
NTS NEV - AREA 51	8.2/354.2	7BE	0.52	0.15	0.0054
HIKO NEV	14.0/354.0	7BE	0.60	0.28	0.017
INDIAN SPRINGS NEV	15.9/359.8	7BE	0.55	0.27	0.019
LAS VEGAS NEV	22.9/363.3	7BE	0.64	0.23	0.026
LATHROP WELLS NEV	14.0/366.6	7BE	0.48	0.36	0.016

CONTINUED

TABLE E-1. CONTINUED

			RADIOACTIVITY CONC. (PCI/M3)		
SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	MAX	MIN	AVG*
OVERTON NEV	18.6/354.3	7BE	0.79	0.32	0.023
PAHRUMP NEV	11.9/361.1	7BE	0.66	0.37	0.016
SCOTTY'S JCT NEV	5.0/355.7	7BE	0.71	0.36	0.0070
SUNNYSIDE NEV	4.9/347.9	7BE	0.59	0.46	0.0075
RACHEL NEV - ROBINSON TRAILER	23.7/361.4	7BE	0.83	0.30	0.028
TONOPAH NEV	5.9/357.7	7BE	0.51	0.45	0.0079
TTR NEV	68.2/360.3	7BE	0.41	0.10	0.044
FALLINI'S (TWIN SPGS) RANCH NE	17.3/359.3	7BE	0.59	0.32	0.023
CEDAR CITY UTAH	18.8/361.6	7BE	0.53	0.31	0.021
DELTA UTAH	13.7/258.6	7BE	0.62	0.32	0.022
MILFORD UTAH	68.6/355.7	7BE	0.41	0.088	0.039
ST GEORGE UTAH	7.0/372.4	7BE	0.78	0.33	0.0094
SALT LAKE CITY UTAH	39.6/366.0	7BE	0.47	0.16	0.033

*TIME-WEIGHTED AVERAGE INCLUDES ALL DAYS OF NON-DETECTABLE ACTIVITY.

THE FOLLOWING STATIONS HAD NEGLIGIBLE GAMMA-SPECTRA:

ALAMO NEV - SHERRI'S RANCH

NYALA NEV

TABLE E-2. 1983 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK STANDBY STATIONS - OPERATED 1 OR 2 WEEKS PER QUARTER

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG
KINGMAN ARIZ	6.1/23.2	7BE	0.43	0.33	0.10
PHOENIX ARIZ	3.0/11.0	7BE	0.27	0.27	0.073
SELIGMAN ARIZ	3.0/14.0	7BE	0.21	0.21	0.046
TUCSON ARIZ	4.0/20.0	7BE	0.33	0.33	0.067
WINSLOW ARIZ	8.0/27.0	7BE	0.23	0.19	0.061
BAKER CALIF	10.1/24.6	7BE	0.27	0.24	0.11
BARSTOW CALIF	5.9/27.9	7BE	0.26	0.20	0.049
BISHOP CALIF	3.2/15.5	7BE	0.56	0.56	0.12
CHICO CALIF	6.0/14.1	7BE	0.28	0.17	0.095
INDIO CALIF	3.0/26.8	7BE	0.21	0.21	0.023
LONE PINE CALIF	2.0/20.0	7BE	0.25	0.25	0.025
NEEDLES CALIF	6.0/28.0	7BE	0.19	0.18	0.039
RIDGECREST CALIF	3.0/21.7	7BE	0.41	0.41	0.056
CORTEZ COLO	2.8/12.6	7BE	0.63	0.63	0.14
DENVER COLO	5.1/26.2	7BE	0.55	0.24	0.072
DURANGO COLO	6.4/14.0	7BE	0.34	0.27	0.14
GRAND JUNCTION COLO	3.1/25.8	7BE	0.26	0.26	0.031
PUEBLO COLO	8.0/13.9	7BE	0.39	0.22	0.16
BOISE IDA	6.0/14.0	7BE	0.21	0.15	0.075
IDAHO FALLS IDA	6.0/13.8	7BE	0.23	0.22	0.098

CONTINUED

TABLE E-2. CONTINUED

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/M3)		
			MAX	MIN	AVG
MOUNTAIN HOME IDA	10.0/28.0	7BE	0.31	0.14	0.078
NAMPA IDA	3.0/14.2	7BE	0.32	0.32	0.067
POCATELLO IDA	6.0/27.8	7BE	0.34	0.26	0.066
TWIN FALLS IDA	5.0/14.0	7BE	0.38	0.29	0.12
IOWA CITY IOWA	3.0/27.0	7BE	0.21	0.21	0.023
SIOUX CITY IOWA	3.0/7.0	7BE	0.17	0.17	0.074
DODGE CITY KAN	3.0/28.0	7BE	0.20	0.20	0.021
MONROE LA	2.1/27.2	7BE	0.22	0.22	0.016
NEW ORLEANS LA	1.9/13.7	7BE	0.19	0.19	0.026
MINNEAPOLIS MINN	2.0/26.1	7BE	0.19	0.19	0.014
CLAYTON MO	8.0/28.0	7BE	0.22	0.16	0.056
ST JOSEPH MO	5.0/35.7	7BE	0.23	0.13	0.024
BILLINGS MONT	3.0/13.9	7BE	0.30	0.30	0.064
BOZEMAN MONT	2.9/9.1	7BE	0.22	0.22	0.069
MISSOULA MONT	3.0/12.5	7BE	0.17	0.17	0.041
BATTLE MOUNTAIN NEV	1.9/21.9	7BE	0.61	0.61	0.053
BLUE JAY NEV	7.0/23.7	7BE	0.39	0.32	0.10
CALIENTE NEV	4.0/26.8	7BE	0.54	0.33	0.064
CURRANT NEV - ANGLE WORM RANCH	2.9/29.3	7BE	0.47	0.47	0.047
CURRIE NEV	4.8/12.6	7BE	0.62	0.62	0.24

CONTINUED

TABLE E-2. CONTINUED

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG
DUCKWATER NEV	11.0/64.1	7BE	0.69	0.19	0.062
ELKO NEV	14.7/31.4	7BE	0.30	0.18	0.094
EUREKA NEV	4.8/20.7	7BE	0.41	0.28	0.078
FALLON NEV	8.0/22.8	7BE	0.40	0.22	0.11
FRENCHMAN STATION NEV	2.9/25.6	7BE	0.24	0.24	0.028
LOVELOCK NEV	5.9/29.4	7BE	0.21	0.17	0.039
LUND NEV	6.9/26.1	7BE	0.47	0.41	0.12
MESQUITE NEV	13.0/22.0	7BE	0.37	0.17	0.17
PIOCHE NEV	6.6/20.3	7BE	0.45	0.32	0.12
RENO NEV	5.0/25.5	7BE	0.78	0.32	0.12
WARM SPRINGS NEV	5.0/20.6	7BE	0.83	0.22	0.14
WELLS NEV	5.0/27.1	7BE	0.40	0.32	0.064
CARLSBAD N M	5.0/22.1	7BE	0.36	0.15	0.053
NORMAN OKLA	3.0/14.0	7BE	0.15	0.15	0.032
DUGWAY UTAH	3.0/7.0	7BE	0.13	0.13	0.055
GARRISON UTAH	4.1/16.1	7BE	0.32	0.32	0.080
CASPER WYO	5.0/14.0	7BE	0.42	0.28	0.12

THE FOLLOWING STATIONS HAD NEGLIGIBLE GAMMA-SPECTRA:

GLOBE ARIZ

YUMA ARIZ

CONTINUED

TABLE E-2. CONTINUED

THE FOLLOWING STATIONS HAD NEGLIGIBLE GAMMA-SPECTRA:

LITTLE ROCK ARK
SANTA ROSA CALIF
PRESTON IDA
FORT DODGE IOWA
LAKE CHARLES LA
JOPLIN MO
GREAT FALLS MONT
KALISPELL MONT
MILES CITY MONT
NORTH PLATTE NEB
GEYSER RANCH NEV
ROUND MOUNTAIN NEV
WINNEMUCCA NEV
ALBUQUERQUE N M
SHIPROCK NM
BISMARK ND
FARGO ND
WILLISTON ND
MUSKOGEE OKLA
MEDFORD ORE
BURNS ORE
ABERDEEN S D
RAPID CITY S D
ABILENE TEX
AMARILLO TEX
AUSTIN TEX
FORT WORTH TEX
MIDLAND TEX
TYLER TEX
BRYCE CANYON UTAH
CAPITOL REEF NAT'L MONUMENT UTAH
ENTERPRISE UTAH
LOGAN UTAH
MONTICELLO UTAH
PAROWAN UTAH
PROVO UTAH
VERNAL UTAH
WENDOVER UTAH
SEATTLE WASH
SPOKANE WASH
ROCK SPRINGS WYO
WORLAND WYO

TABLE E-3. 1983 SUMMARY OF ANALYTICAL RESULTS FOR THE NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

SAMPLING LOCATION	NUMBER SAMPLES POSITIVE/ NEGATIVE	RADIONUCLIDE	RADIOACTIVITY CONC. (PCI/M3)*			PERCENT CONC. GUIDE±
			MAX	MIN	AVG	
SHOSHONE, CALIF.	42/10	85KR	31	19	25	0.03
	41/11	133XE	47	-6.9	2.8	<0.01
	50/1	3H IN ATM. M.*	0.55	-0.46	0.065	-
	50/1	3H AS HTO IN AIR	4.8	-2.5	0.43	<0.01
ALAMO, NEV.	41/11	85KR	33	19	25	0.02
	39/13	133XE	18	-9.1	1.7	<0.01
	52/0	3H IN ATM. M.*	0.44	-0.26	0.056	-
	52/0	3H AS HTO IN AIR	3.8	-2.2	0.47	<0.01
AUSTIN, NEV.	49/3	85KR	30	19	25	0.03
	45/7	133XE	24	-12	2.1	<0.01
	52/0	3H IN ATM. M.*	0.49	-0.22	0.097	-
	52/0	3H AS HTO IN AIR	2.9	-1.1	0.55	<0.01
BEATTY, NEV.	46/6	85KR	30	20	24	0.02
	45/7	133XE	23	-12	2.9	<0.01
	52/0	3H IN ATM. M.*	0.33	-0.20	0.086	-
	52/0	3H AS HTO IN AIR	2.2	-1.3	0.48	<0.01
ELY, NEV.	48/4	85KR	31	19	25	0.02
	45/7	133XE	24	-2.9	3.8	<0.01
	52/0	3H IN ATM. M.*	0.44	-0.37	0.081	-
	52/0	3H AS HTO IN AIR	3.1	-2.7	0.46	<0.01
GOLDFIELD, NEV.	50/2	85KR	30	20	24	0.02
	50/2	133XE	11	-8.2	1.0	<0.01
	52/0	3H IN ATM. M.*	0.35	-0.27	0.053	-
	52/0	3H AS HTO IN AIR	2.3	-1.1	0.32	<0.01
INDIAN SPRINGS, NEV.	44/8	85KR	31	19	25	0.02
	44/8	133XE	8.8	-25	1.2	<0.01
	52/0	3H IN ATM. M.*	0.50	-0.27	0.057	-
	52/0	3H AS HTO IN AIR	3.7	-4.4	0.34	<0.01
LAS VEGAS, NEV.	46/6	85KR	31	20	24	0.02
	44/8	133XE	30	-28	1.3	<0.01
	51/1	3H IN ATM. M.*	0.50	-0.34	0.079	-
	51/1	3H AS HTO IN AIR	5.0	-2.3	0.58	<0.01

(CONTINUED)

TABLE E-3. CONTINUED

SAMPLING LOCATION	NUMBER SAMPLES POSITIVE/ NEGATIVE	RADIONUCLIDE	RADIOACTIVITY CONC. (PCI/M3)*			PERCENT CONC. GUIDE±
			MAX	MIN	AVG	
LATHROP WELLS, NEV.	50/2	85KR	32	19	26	0.03
	49/3	133XE	26	-9.9	4.8	<0.01
	52/0	3H IN ATM. M.*	0.42	-0.22	0.10	-
	52/0	3H AS HTO IN AIR	2.8	-2.1	0.54	<0.01
OVERTON, NEV.	48/4	85KR	30	19	25	0.02
	47/5	133XE	35	-11	5.3	<0.01
	51/1	3H IN ATM. M.*	0.48	-0.18	0.060	-
	51/1	3H AS HTO IN AIR	4.7	-1.7	0.44	<0.01
PAHRUMP, NEV.	42/10	85KR	30	18	24	0.02
	39/13	133XE	7.6	-9.2	1.9	<0.01
	52/0	3H IN ATM. M.*	0.51	-0.30	0.048	-
	52/0	3H AS HTO IN AIR	3.5	-3.5	0.25	<0.01
RACHEL, NEV.	45/6	85KR	31	20	24	0.02
	44/7	133XE	16	-56	0.74	<0.01
	52/0	3H IN ATM. M.*	0.48	-0.20	0.13	-
	52/0	3H AS HTO IN AIR	4.4	-1.1	0.71	<0.01
TONOPAH, NEV.	44/7	85KR	32	21	25	0.03
	42/9	133XE	54	-13	3.4	<0.01
	52/0	3H IN ATM. M.*	0.39	-0.34	0.083	-
	52/0	3H AS HTO IN AIR	2.5	-2.2	0.47	<0.01
CEDAR CITY, UTAH	46/6	85KR	28	18	24	0.02
	42/10	133XE	16	-6.7	2.3	<0.01
	52/0	3H IN ATM. M.*	0.53	-0.25	0.074	-
	52/0	3H AS HTO IN AIR	2.8	-1.2	0.46	<0.01
ST GEORGE, UTAH	47/5	85KR	32	19	25	0.02
	44/8	133XE	11	-11	0.61	<0.01
	49/2	3H IN ATM. M.*	0.40	-0.31	0.087	-
	49/2	3H AS HTO IN AIR	3.6	-2.5	0.62	<0.01
SALT LAKE CITY, UTAH	31/15	85KR	34	18	25	0.03
	29/17	133XE	32	-6.3	2.6	<0.01
	47/4	3H IN ATM. M.*	0.52	-0.25	0.12	-
	47/4	3H AS HTO IN AIR	4.4	-1.8	0.75	<0.01

* CONCENTRATIONS OF TRITIUM IN ATMOSPHERIC MOISTURE (ATM. M.) ARE EXPRESSED AS PCI PER ML OF WATER COLLECTED.

± CONCENTRATION GUIDES USED ARE FOR EXPOSURE TO A SUITABLE SAMPLE OF THE POPULATION IN AN UNCONTROLLED AREA.

TABLE E-4. 1983 SUMMARY OF GROSS BETA ANALYSES FOR AIR SURVEILLANCE NETWORK

SAMPLING LOCATION	NO. DAYS SAMPLED	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG
SHOSHONE CALIF	350.4	0.083	-0.027	0.0064
LAS VEGAS NEV	360.2	0.082	-0.016	0.010
DELTA UTAH	255.8	0.027	-0.0080	0.0076
MILFORD UTAH	355.7	0.029	-0.011	0.0082
ST GEORGE UTAH	372.4	0.039	-0.0058	0.0082

TABLE E-5. PLUTONIUM CONCENTRATION IN COMPOSITED AIR SAMPLES - 1983

Station Location	Month Collected	Pu-238* aCi/m^3	Pu-239* aCi/m^3	Pct. CG
(WINSLOW and PHOENIX)	Feb	5.3	9.9	<0.08
AZ	May	0	0	-
(BARSTOW and BISHOP)	Feb	0.9	5.5	0.04
CA	May	NA	NA	-
(DURANGO and PUEBLO)	Feb	0	1.2	<0.01
CO	May	0	5.1	<0.04
(BOISE and MOUNTAIN HOME)	Feb	2.6	1.6	<0.02
ID	May	0	4.7	<0.03
(IOWA CITY and SIOUX CITY)	Feb	34	7.3	<0.2
IA	May	0	1.1	<0.01
(MNROE and NEW ORLEANS)	Feb	4.6	2.2	<0.04
LA	May	2.1	1.6	<0.03
(JOPLIN and ST. JOSEPH)	Feb	0.9	2.7	<0.03
MO	May	0	13.6*	0.07
(BOZEMAN and MISSOLULA)	Feb	0	2.7	<0.02
MT	May	0	4.0	0.02
LAS VEGAS, NV	Jan thru Jun	3.3 ± 3.2**	4.8 ± 2.8**	0.04
LATHROP WELLS, NV	Jan thru Jun	4.2 ± 4.1**	7.8 ± 4.6**	0.06
RACHEL, NV	Jan thru Jun	1.4 ± 3.4**	5.4 ± 4.3**	<0.04
(ALBUQUERQUE and CARLSBAD)	Feb	3.0	4.5	<0.04
NM	May	3.8	6.4	0.05
(MUSKOGEE and NORMAN)	Jan	0	2.3	<0.02
OK	Feb	4.5	2.0	<0.04
	May	0	2.9	<0.02
(BURNS and MEDFORD)	Jan	2.6	2.2	<0.03
OR	Mar	0	0.9	<0.01
	Jun	4.9	7.3	0.06

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*All results less than MDC except the May composite from Missouri. A negative result is indicated by 0.

**Average and std. deviation of the six monthly composites. All less than MDC.

CONTINUED

TABLE E-5. CONTINUED

Station Location	Month Collected	Pu-238* aCi/m^3	Pu-239* aCi/m^3	Pct. CG
(ABERDEEN and RAPID CITY)	Mar	0.6	2.6	<0.02
SD	Jun	NA	NA	-
(AUSTIN and FT. WORTH)	Mar	0	2.4	<0.02
TX	Jun	NA	NA	-
(PROVO and VERNAL)	Mar	3.6	1.4	<0.03
UT	Jun	NA	NA	-
(SEATTLE and SPOKANE)	Mar	0	0	-
WA	Jun	0	2.3	<0.02
(CASPER and WORLAND)	Feb	3.0	0.8	<0.03
WY	May	0	NA	-

*All results less than MDC except the May composite from Missouri. A negative result is indicated by 0.

TABLE E-6. 1983 SUMMARY OF TRITIUM RESULTS FOR THE NTS MONTHLY LONG-TERM HYDROLOGICAL MONITORING PROGRAM

SAMPLING LOCATION	NO. SAMPLES	TRITIUM CONCENTRATION (PCI/L) MAX	MIN	AVG	PERCENT CONC. GUIDE
WELL 8	11	9.4	-4.7	1.5	<0.01
WELL J-12	1	-3.0	-3.0	-3.0	<0.01
WELL A	11	23	-2.4	5.4	0.03
WELL C	11	120	-2.0	36	0.20
WELL 5C	11	6.4	-6.0	-0.42	<0.01
WELL ARMY 1	11	88	-4.2	9.8	0.05
WELL 2	11	9.7	-1.5	2.6	0.02
TEST WELL B	11	180	110	150	0.75
WELL 3	11	49	-19	6.0	0.03
WELL 4	11	4.7	-9.4	-0.66	<0.01
WELL J-13	10	8.8	-10	0.40	<0.01
WELL U19C	11	10	-3.2	1.8	<0.01
WELL UE7NS	1	-	-	1500	7.5

TABLE E-7. TRITIUM RESULTS FOR THE LONG-TERM HYDROLOGICAL MONITORING PROGRAM NTS SEMI-ANNUAL PROJECT FOR 1983

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
BOULDER CITY NEV LAKE MEAD INTAKE	01/17	220 ± 7	1
	07/15	190 ± 7	0.9
ASH MEADOWS NEV CRYSTAL POOL	01/11	3.2 ± 5.6*	0.02
	07/07	1.6 ± 5.2*	<0.01
WELL 18S-51E-7DB	01/11	0.73 ± 5.3*	<0.01
	07/07	3.5 ± 5.3*	0.02
WELL 17S-50E-14CAC	01/11	-2.1 ± 5.6*	<0.01
	07/07	3.5 ± 5.0*	0.02
FAIRBANKS SPRINGS	01/11	2.5 ± 5.3*	0.01
	07/07	3.9 ± 5.0*	0.02
BEATTY NEV NECO WELL	01/12	2.0 ± 5.3*	0.01
	07/06	6.3 ± 5.0*	0.03
COFFERS WELL 11S/48/1DD	01/12	7.1 ± 6.0*	0.04
	07/12	3.4 ± 4.9*	0.02
CITY SUPPLY 12S-47E-7DB	01/12	12 ± 5	0.06
	07/12	10 ± 5	0.05
INDIAN SPRINGS NEV USAF WELL 2	01/11	9.8 ± 5.0	0.05
	07/06	7.5 ± 4.3	0.04
SEWER CO INC WELL 1	01/11	19 ± 5	0.09
	07/06	3.3 ± 5.2*	0.02

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*CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

CONTINUED

TABLE E-7. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
LATHROP WELLS NEV CITY 15S-50E-18CDC	01/12	1.0 ± 5.9*	<0.01
	07/06	2.8 ± 5.1*	0.01
NTS NEV WELL UE18R	01/14	NO SAMPLE COLLECTED	
WELL UE15D	01/13	NO SAMPLE COLLECTED	
	07/08	42 ± 5	0.2
TEST WELL D	01/13	73 ± 5	0.4
	07/13	5.2 ± 5.3*	0.03
WELL UE1C	01/13	8.2 ± 5.0	0.04
	07/13	3.1 ± 5.0*	0.02
WELL C-1	01/19	140 ± 6	0.7
	07/08	14 ± 5	0.07
WELL UE5C	01/18	9.8 ± 5.7	0.05
	07/13	4.2 ± 5.0*	0.02
WELL 5B	01/18	11 ± 5	0.05
	07/13	5.1 ± 5.7*	0.03
TEST WELL F	01/14	NO SAMPLE COLLECTED	
WELL U16D	01/19	1.8 ± 5.4*	<0.01
	07/08	0.24 ± 5.1*	<0.01
OASIS VALLEY NEV GOSS SPRINGS	01/12	8.1 ± 4.8	0.04
	07/12	4.0 ± 5.2*	0.02

*CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

TABLE E-8. TRITIUM RESULTS FOR THE LONG-TERM HYDROLOGICAL MONITORING PROGRAM NTS ANNUAL PROJECT FOR 1983

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
SHOSHONE CA SHOSHONE SPRING	08/16	1.1 ± 5.5*	<0.01
ADAVEN NEV ADAVEN SPRING	08/01	650 ± 150	3
ALAMO NEV CITY WELL 4	08/09	-0.82 ± 5.3*	<0.01
CLARK STATION NEV TTR WELL 6	08/02	1.2 ± 5.0*	<0.01
HIKO NEV CRYSTAL SPRINGS	08/09	71 ± 5	0.4
LAS VEGAS NEV WATER DISTRICT WELL 28	08/17	-3.4 ± 5.7*	<0.01
NYALA NEV SHARP'S RANCH	08/01	2.2 ± 5.6*	0.01
PAHRUMP NEV CALVADA WELL 3	08/16	0.80 ± 5.4*	<0.01
TEMPIUTE NEV UNION CARBIDE WELL	08/10	0.21 ± 5.0*	<0.01
TONOPAH NEV CITY WELL	08/02	-3.4 ± 5.4*	<0.01
WARM SPRINGS NEV TWIN SPRINGS RCH	08/03	1.8 ± 5.5*	<0.01

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

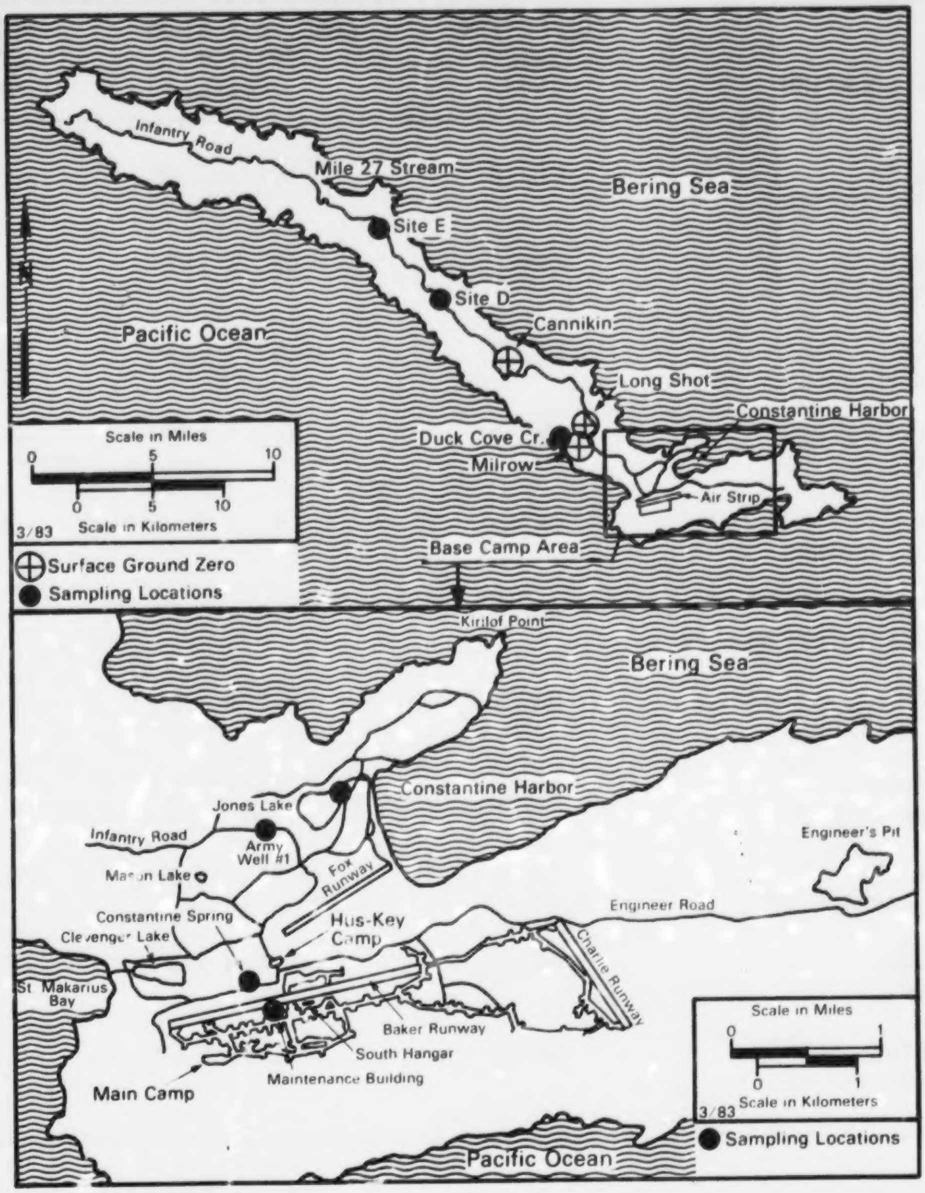
Infantry Road
Mile 27 Stream
Bering Sea
Site E
Site D
Pacific Ocean
Cannikin
Long Shot
Constantine Harbor
Duck Cove Cr.
Milrow
Air Strip
Scale in Miles
0
5
10
0
5
10
Scale in Kilometers
3/83
Surface Ground Zero
Sampling Locations
Base Camp Area
N
Kirilof Point
Bering Sea
Constantine Harbor
Jones Lake
Infantry Road
Army Well #1
Mason Lake
Fox Runway
Engineer's Pit
Engineer Road
Constantine Spring
Hus-Key Camp
Clevenger Lake
St. Makarius Bay
Charlie Runway
Baker Runway
South Hangar
Maintenance Building
Main Camp
Scale in Miles
0
1
0
1
Scale in Kilometers
3/83
Pacific Ocean
Sampling Locations

Figure E-1 Amchitka Island and background sampling locations for the LTHMP.

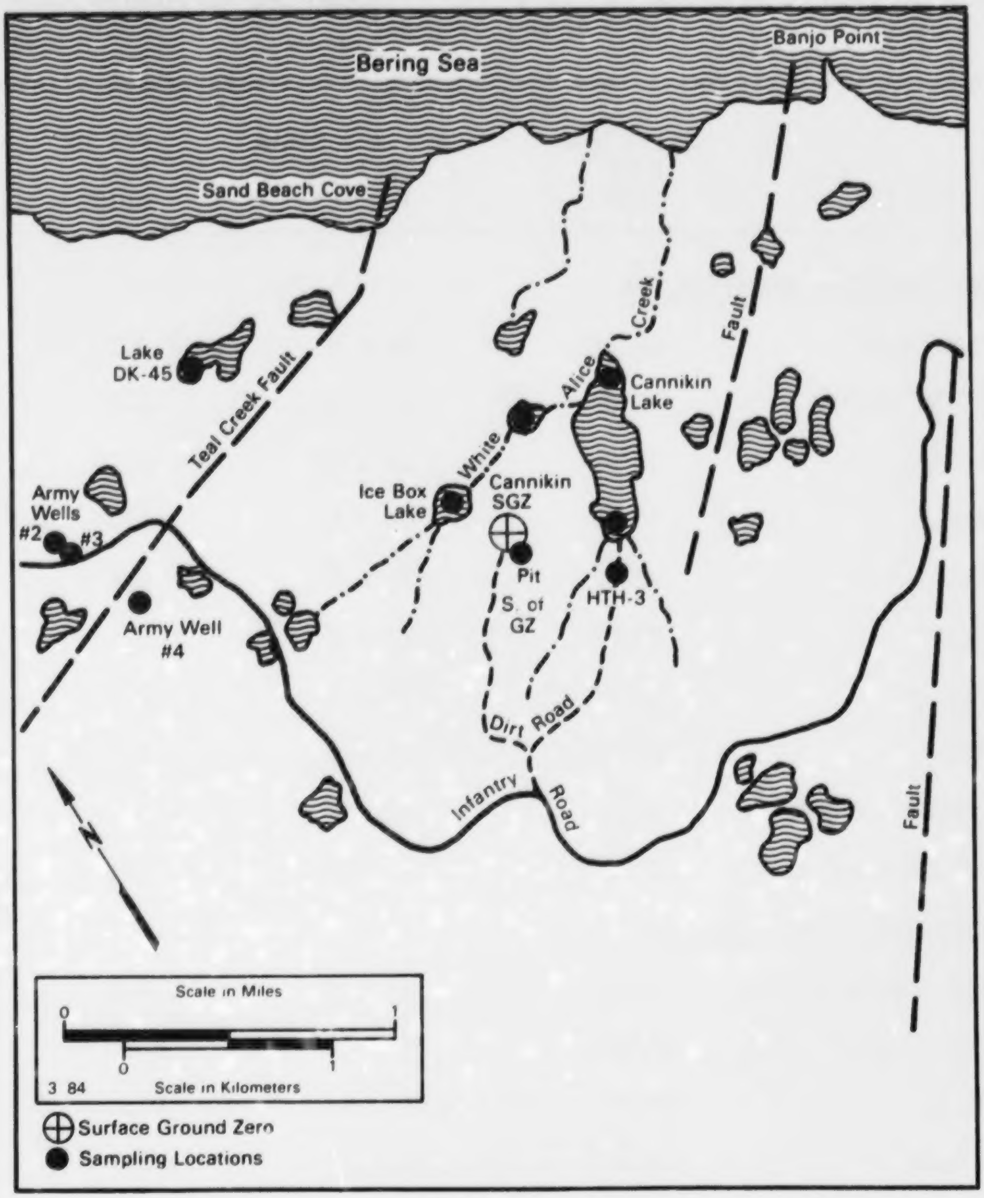
Bering Sea
Banjo Point
Sand Beach Cove
Lake
DK-45
Teal Creek Fault
Army
Wells
#2
#3
Army Well
#4
Ice Box
Lake
White
Alice
Creek
Cannikin
Lake
Cannikin
SGZ
Pit
S. of
GZ
HTH-3
Fault
Fault
Dirt Road
Infantry
Road
N
Scale in Miles
0
1
0
1
3 84
Scale in Kilometers
Surface Ground Zero
Sampling Locations

Figure E-2. LTHMP sampling locations for Project Cannikin.

TABLE E-9. TRITIUM RESULTS FOR THE LONG-TERM HYDROLOGICAL MONITORING PROGRAM (1983 Annual Samples)

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
BACKGROUND SAMPLES - AMCHITKA, AK			
DUCK COVE CREEK	08/08	46 ± 5	0.2
CONSTANTINE SPRING	08/09	91 ± 6	0.5
JONES LAKE	08/08	39 ± 5	0.2
RAIN SAMPLE	08/16	55 ± 6	0.3
ARMY WELL 1	08/09	71 ± 6	0.4
ARMY WELL 2	08/09	26 ± 6	0.1
ARMY WELL 3	08/09	74 ± 5	0.4
ARMY WELL 4	08/09	77 ± 6	0.4
SITE E HYDRO EXPLOR HOL	08/09	170 ± 6	0.8
SITE D HYDRO EXPLOR HOL	08/09	88 ± 5	0.4
PROJECT CANNIKIN - AMCHITKA, AK			
SOUTH END CANNIKIN LAKE	08/08	51 ± 6	0.3
NORTH END CANNIKIN LAKE	08/08	30 ± 5	0.2
WELL HTH-3	08/08	51 ± 6	0.3
ICE BOX LAKE	08/08	44 ± 5	0.2
WHITE ALICE CREEK	08/08	48 ± 5	0.2
PIT S OF CANNIKIN GZ	08/08	34 ± 5	0.2
DK-45 LAKE	08/10	61 ± 6	0.3

CONTINUED

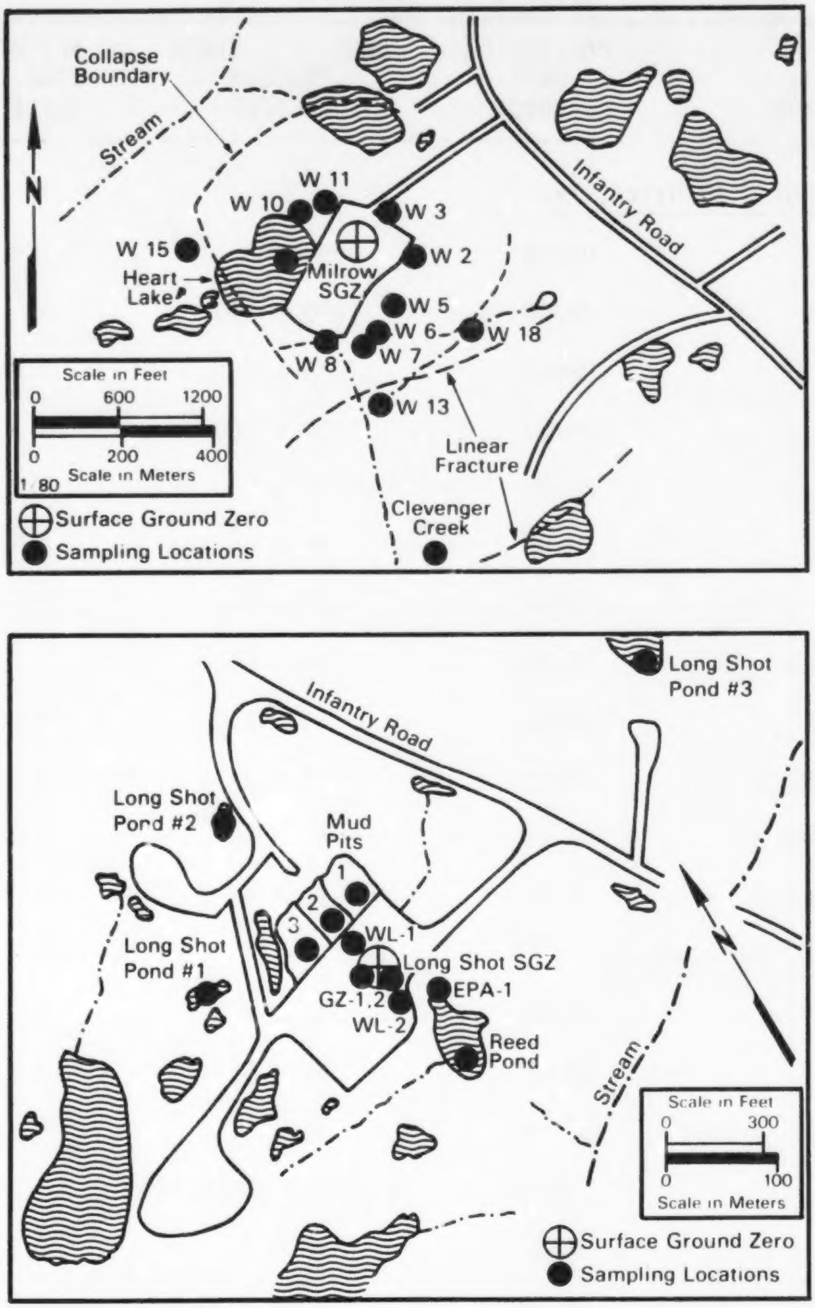
Collapse Boundary
Stream
N
W 11
W 10
W 3
W 15
W 2
Heart Lake
Milrow SGZ
W 5
W 6
W 18
W 8
W 7
W 13
Infantry Road
Scale in Feet
0
600
1200
0
200
400
Scale in Meters
1 80
Linear Fracture
Surface Ground Zero
Sampling Locations
Clevenger Creek
Long Shot Pond #3
Infantry Road
Long Shot Pond #2
Mud Pits
1
2
3
WL-1
Long Shot Pond #1
Long Shot SGZ
EPA-1
GZ-1,2
WL-2
Reed Pond
N
Stream
Scale in Feet
0
300
0
100
Scale in Meters
Surface Ground Zero
Sampling Locations

Figure E-3. LTHMP sampling locations for Projects Milrow and Long Shot.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT LONG SHOT - AMCHITKA, AK			
WELL WL-2	08/08	290 ± 8	1
EPA WELL-1	08/08	820 ± 150	4
REED POND	08/08	76 ± 6	0.4
WELL GZ 1	08/08	3800 ± 180	20
WELL GZ 2	08/08	270 ± 8	1
WELL WL-1	08/08	59 ± 6	0.3
MUD PIT 1	08/08	600 ± 140	3
MUD PIT 2	08/08	590 ± 140	3
MUD PIT 3	08/08	740 ± 150	4
LONG SHOT POND 1	08/08	51 ± 6	0.3
LONG SHOT POND 2	08/08	57 ± 6	0.3
LONG SHOT POND 3	08/08	51 ± 5	0.3
PROJECT MILROW - AMCHITKA, AK			
HEART LAKE	08/08	31 ± 5	0.2
WELL W-2	08/08	41 ± 5	0.2
WELL W-3	08/08	33 ± 5	0.2
WELL W-4	08/08	NO SAMPLE COLLECTED	
WELL W-5	08/08	38 ± 5	0.2
WELL W-6	08/08	42 ± 5	0.2
WELL W-7	08/08	44 ± 5	0.2
WELL W-8	08/08	40 ± 5	0.2

CONTINUED

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT MILROW - AMCHITKA, AK (Cont.)			
WELL W-10	08/08	47 ± 5	0.2
WELL W-11	08/08	98 ± 6	0.5
WELL W-13	08/08	58 ± 5	0.3
WELL W-15	08/08	37 ± 5	0.2
WELL W-16	08/08	49 ± 5	0.2
WELL W-18	08/08	60 ± 6	0.3
WELL W-19	08/08	NO SAMPLE COLLECTED	
CLEVENGER CREEK	08/10	51 ± 5	0.3

---

* CONCENTRATION IS LESS THAN MINIMUM DETECTABLE CONCENTRATION (MDC).

CONTINUED

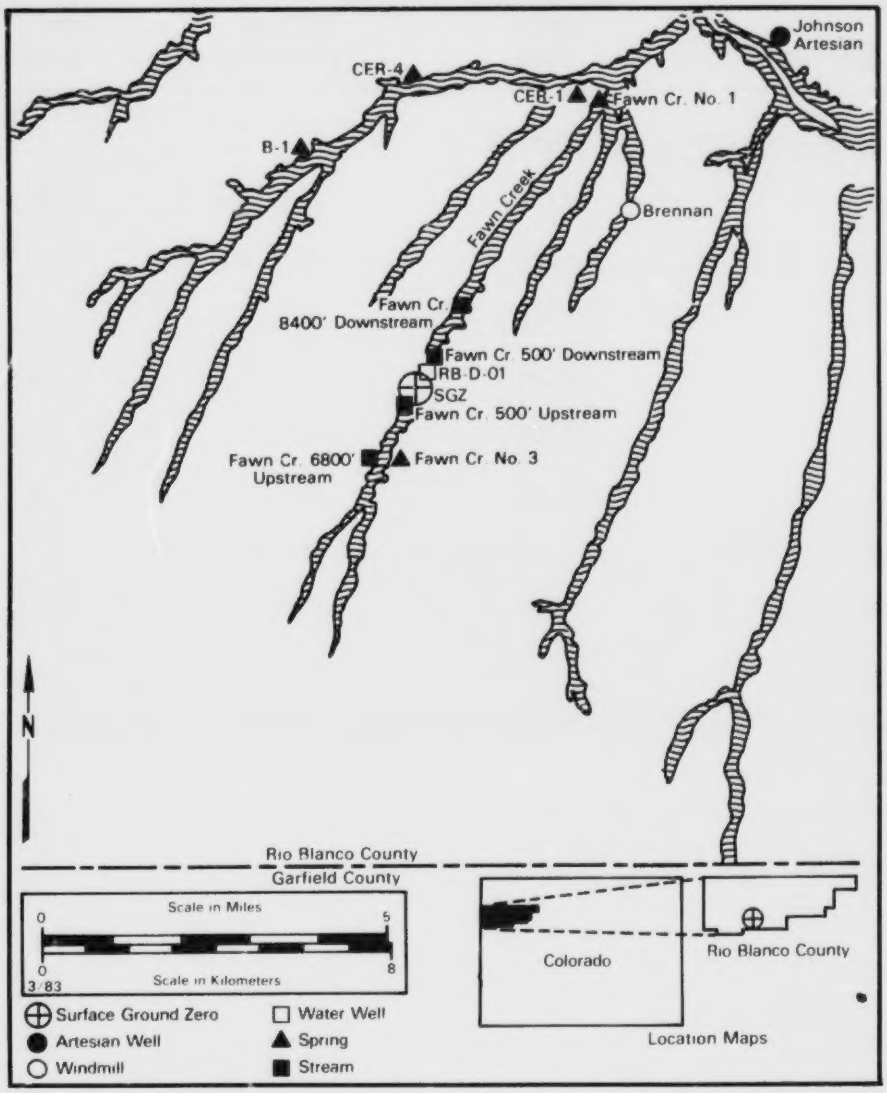
Johnson Artesian
CER-4
CER-1
Fawn Cr. No. 1
B-1
Brennan
Fawn Creek
Fawn Cr. 8400' Downstream
Fawn Cr. 500' Downstream
RB-D-01
SGZ
Fawn Cr. 500' Upstream
Fawn Cr. 6800' Upstream
Fawn Cr. No. 3
N
Rio Blanco County
Garfield County
Scale in Miles
0
5
0
8
Scale in Kilometers
3/83
Surface Ground Zero
Artesian Well
Windmill
Water Well
Spring
Stream
Colorado
Rio Blanco County
Location Maps

Figure E-4. LTHMP sampling locations for Project Rio Blanco.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT RIO BLANCO - RIO BLANCO, CO			
FAWN CREEK 6800 FT UPSTREAM	05/31	130 ± 6	0.6
FAWN CREEK 500 FT UPSTREAM	05/31	140 ± 6	0.7
FAWN CREEK 500FT DOWNSTREAM	05/31	130 ± 6	0.7
FAWN CREEK 8400 FT DOWNSTREAM	05/31	130 ± 6	0.6
FAWN CREEK 1	05/31	68 ± 5	0.3
FAWN CREEK 3	05/31	82 ± 5	0.4
CER 1 BLACK SULPHUR	06/01	140 ± 6	0.7
CER 4 BLACK SULPHUR	06/01	120 ± 6	0.6
B-1 EQUITY CAMP	06/01	160 ± 6	0.8
BRENNAN WINDMILL	06/01	96 ± 5	0.5
JOHNSON ARTESIAN WELL	06/01	4.7 ± 4.8*	0.02
WELL RB-D-01	05/31	0.21 ± 6.1*	<0.01

---

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

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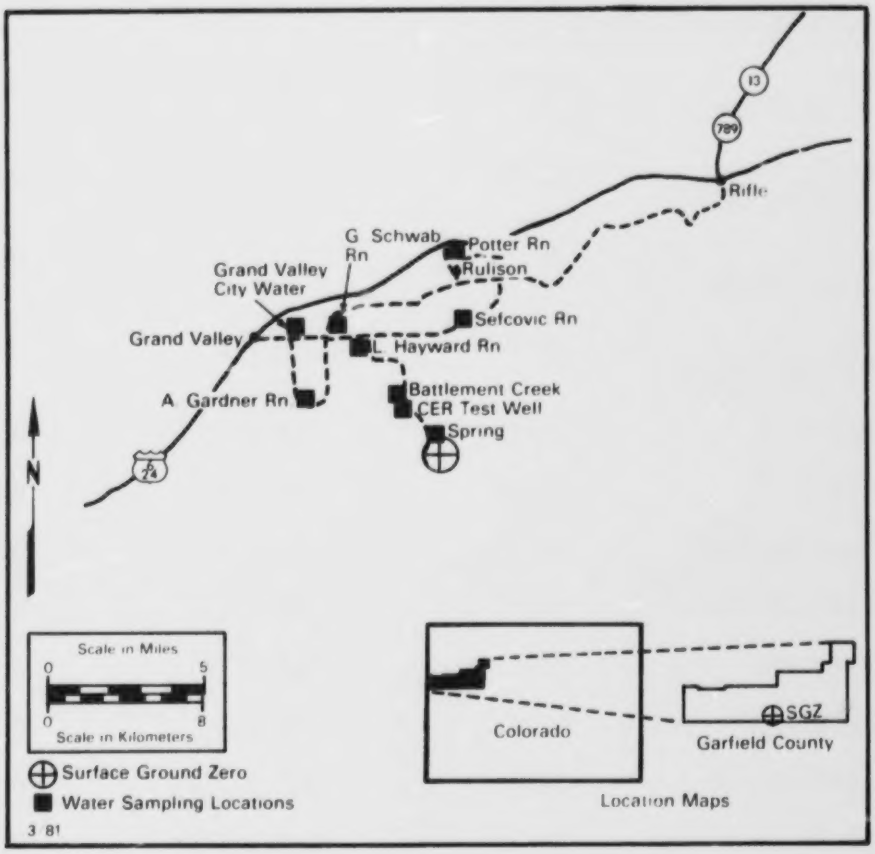
13
789
Rifle
G Schwab
Rn
Potter Rn
Rulison
Grand Valley
City Water
Sefcovic Rn
Grand Valley
L Hayward Rn
Battlement Creek
A Gardner Rn
CER Test Well
Spring
N
74
Scale in Miles
0
5
0
8
Scale in Kilometers
Surface Ground Zero
Water Sampling Locations
3 81
Colorado
SGZ
Garfield County
Location Maps

Figure E-5. LTHMP sampling locations for Project Rulison.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT RULISON - GRAND VALLEY, CO			
ALBERT GARDNER RANCH	05/29	260 ± 7	1
GRAND VALLEY CITY SPRIN	05/29	110 ± 6	0.6
SPRING 300 YRDS NW OF G	05/30	NO SAMPLE COLLECTED	
BATTLEMENT CREEK	05/30	200 ± 7	1
CER TEST WELL	05/30	NO SAMPLE COLLECTED	
LEE HAYWARD RANCH	05/29	260 ± 7	1
G. SCHWAB RANCH (R. SEARCY)	05/29	170 ± 6	0.9
FELIX SEFCOVIC RANCH	05/29	360 ± 8	2
POTTER RANCH	05/30	250 ± 7	1

---

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

CONTINUED

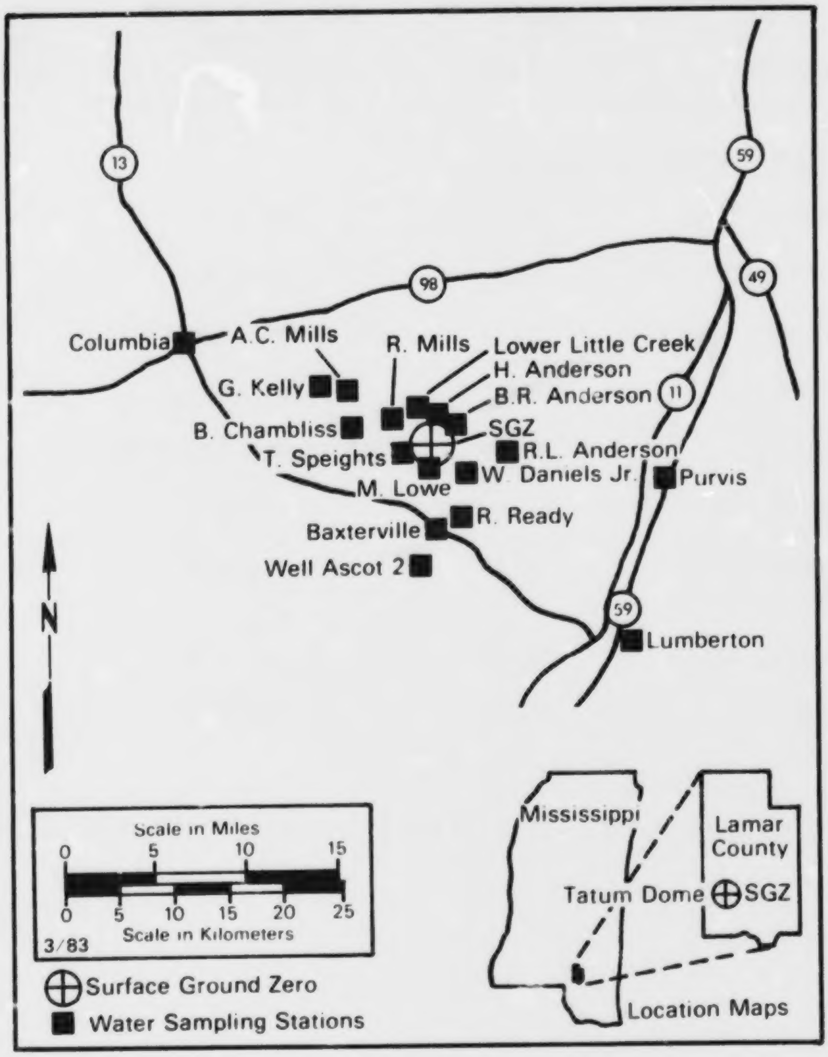
13
59
98
49
11
59
Columbia
A.C. Mills
G. Kelly
B. Chambliss
T. Speights
M. Lowe
R. Mills
Lower Little Creek
H. Anderson
B.R. Anderson
SGZ
R.L. Anderson
W. Daniels Jr.
Purvis
R. Ready
Baxterville
Well Ascot 2
Lumberton
N
Scale in Miles
0
5
10
15
0
5
10
15
20
25
Scale in Kilometers
3/83
Surface Ground Zero
Water Sampling Stations
Mississippi
Lamar County
Tatum Dome
SGZ
Location Maps

Figure E-6. LTHMP sampling locations for Project Dribble - towns and residences.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT DRIBBLE - BAXTERVILLE, MS			
BAXTERVILLE CITY WELL	11/03	62 ± 6	0.3
COLUMBIA MS CITY WELL 64B	11/03	-3.7 ± 7.3*	<0.01
LUMBERTON MS CITY WELL 2	11/03	-11 ± 7*	<0.01
PURVIS MS CITY SUPPLY	11/03	-8.0 ± 6.2*	<0.01
HALF MOON CREEK	11/04	52 ± 5	0.3
LOWER LITTLE CREEK	11/05	53 ± 5	0.3
B R ANDERSON	11/04	30 ± 6	0.1
H ANDERSON	11/04	34 ± 5	0.2
R L ANDERSON	11/04	39 ± 6	0.2
B CHAMBLISS	11/04	1.9 ± 5.0*	<0.01
W DANIELS JR	11/04	43 ± 5	0.2
G KELLY	11/04	-0.91 ± 4.9*	<0.01
M LOWE	11/05	32 ± 5	0.2
A C MILLS	11/04	4.7 ± 5.2*	0.02
R MILLS	11/04	52 ± 6	0.3
R READY	11/04	81 ± 5	0.4
T SPEIGHTS	11/04	83 ± 6	0.4
WELL ASCOT 2	11/04	NO SAMPLE COLLECTED	

---

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

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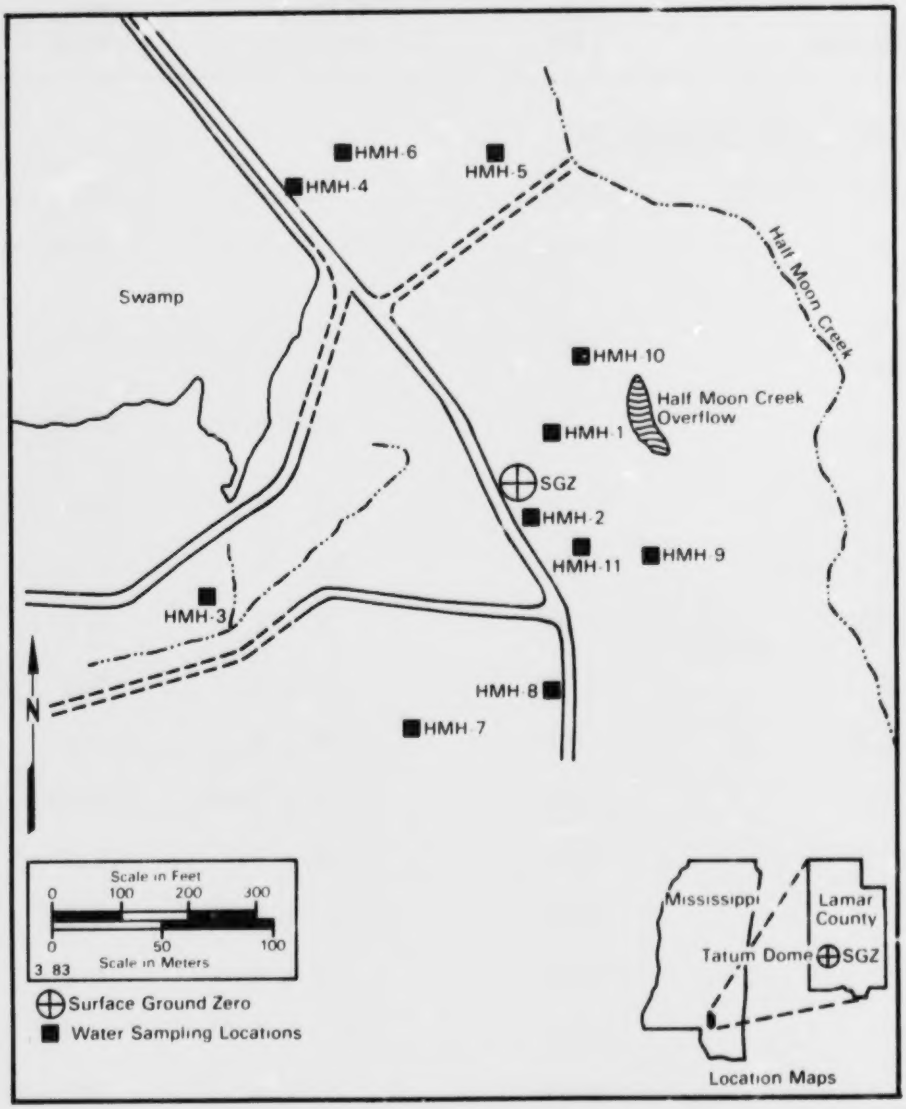
HMH-6
HMH-5
HMH-4
Half Moon Creek
Swamp
HMH-10
Half Moon Creek Overflow
HMH-1
SGZ
HMH-2
HMH-11
HMH-9
HMH-3
N
HMH-8
HMH-7
Scale in Feet
0
100
200
300
0
50
100
Scale in Meters
3 83
Surface Ground Zero
Water Sampling Locations
Mississippi
Lamar County
Tatum Dome
SGZ
Location Maps

Figure E-7. LTHMP sampling locatiions for Project Dribble - near GZ.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT DRIBBLE - BAXTERVILLE, MS (Cont.)			
HALF MOON CREEK OVRFLW	11/03	550 ± 150	3
WELL E-7	11/05	1.2 ± 6.1*	<0.01
WELL HM-1	11/03	1.6 ± 4.9*	<0.01
WELL HM-2A	11/03	-2.9 ± 5.4*	<0.01
WELL HM-2B	11/03	0.33 ± 4.9*	<0.01
WELL HM-3	11/03	1.9 ± 5.2*	<0.01
WELL HMH-1	11/04	85000 ± 590	400
WELL HMH-2	11/04	16000 ± 280	80
WELL HMH-3	11/03	140 ± 6	0.7
WELL HMH-4	11/03	38 ± 5	0.2
WELL HMH-5	11/04	11000 ± 250	50
WELL HMH-6	11/04	1300 ± 160	7
WELL HMH-7	11/03	460 ± 9	2
WELL HMH-8	11/03	51 ± 5	0.3
WELL HMH-9	11/03	63 ± 5	0.3
WELL HMH-10	11/04	200 ± 7	1
WELL HMH-11	11/03	470 ± 140	2
WELL HM-L	11/03	2200 ± 170	10
	11/03	1300 ± 160	7
	11/03	1300 ± 180	7

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

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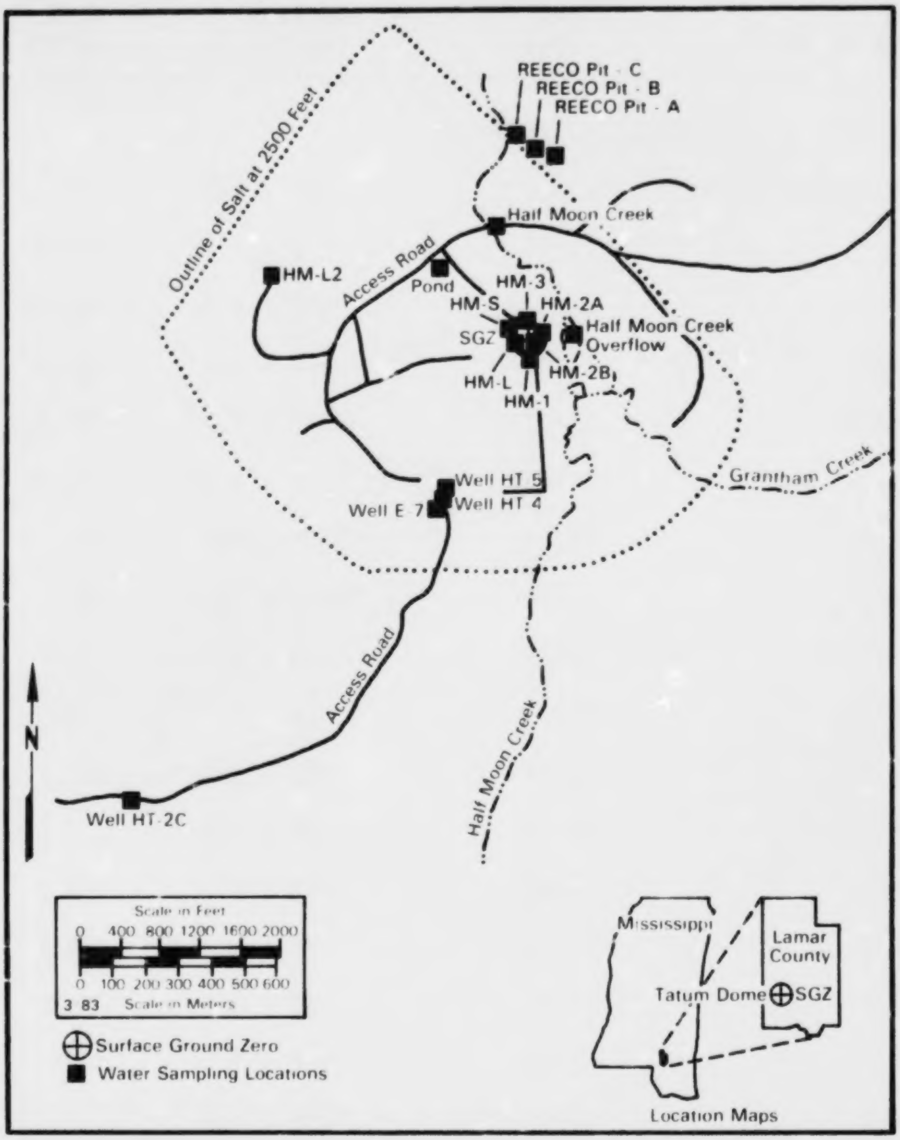
REECO Pit - C
REECO Pit - B
REECO Pit - A
Outline of Salt at 2500 Feet
Half Moon Creek
HM-L2
Access Road
Pond
HM-3
HM-S
HM-2A
SGZ
Half Moon Creek Overflow
HM-2B
HM-L
HM-1
Grantham Creek
Well HT-5
Well HT-4
Well E-7
Access Road
Half Moon Creek
N
Well HT-2C
Scale in Feet
0 400 800 1200 1600 2000
0 100 200 300 400 500 600
3 83 Scale in Meters
Surface Ground Zero
Water Sampling Locations
Mississippi
Lamar County
Tatum Dome
SGZ
Location Maps

Figure E-8. LTHMP sampling locations for Project Dribble - near salt dome.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT DRIBBLE - BAXTERVILLE, MS (Cont.)			
WELL HM-L	11/03	1400 ± 180	7
	11/03	1400 ± 180	7
	11/03	1500 ± 180	7
	11/03	1400 ± 160	7
WELL HM-L2	11/04	-0.91 ± 5.3*	<0.01
WELL HM-S	11/04	19000 ± 300	90
	11/05	19000 ± 330	100
	11/06	19000 ± 330	100
	11/07	19000 ± 330	100
WELL HT-2C	11/07	23 ± 4	0.1
WELL HT-4	11/05	9.9 ± 4.5	0.05
WELL HT-5	11/05	-0.88 ± 5.7*	<0.01
REECO PIT DRAINAGE-A	11/04	NO SAMPLE COLLECTED	
REECO PIT DRAINAGE-B	11/04	12000 ± 250	60
REECO PIT DRAINAGE-C	11/04	NO SAMPLE COLLECTED	
POND WEST OF GZ	11/04	79 ± 5	0.4

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

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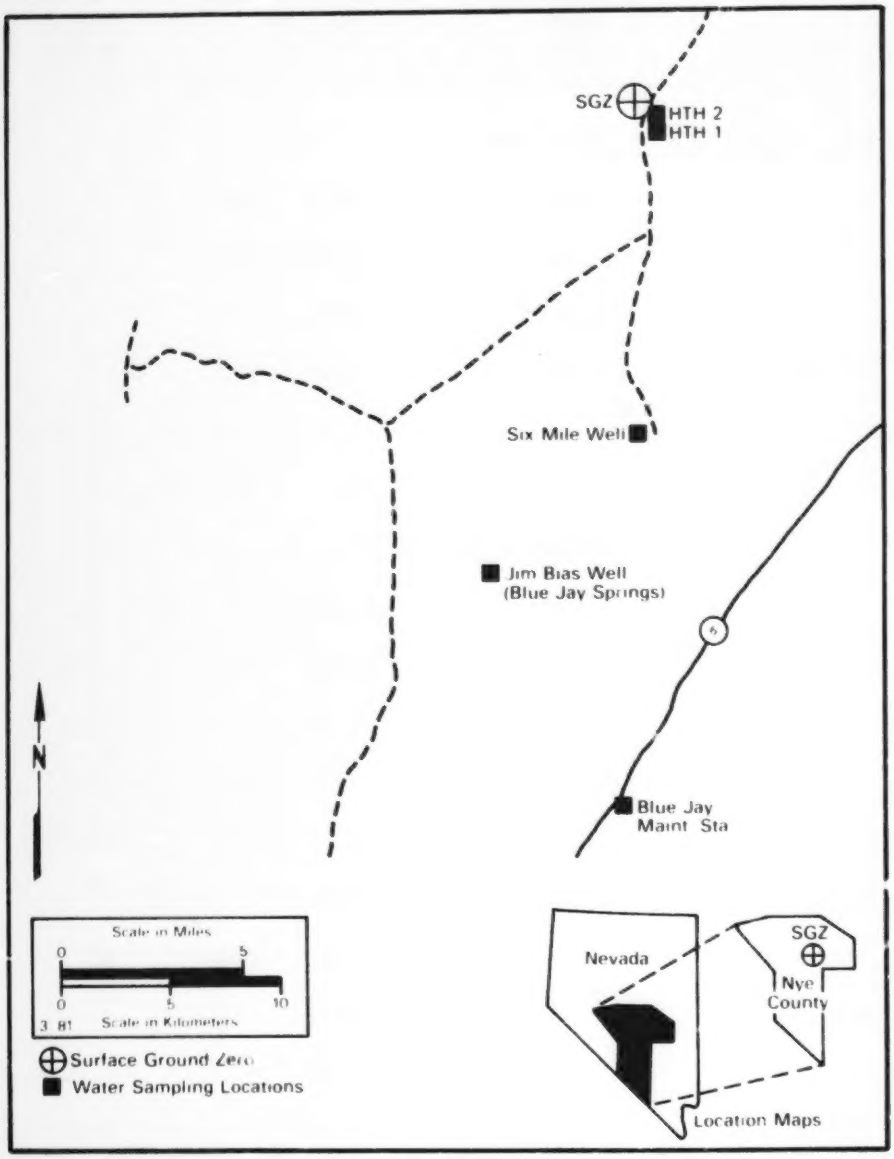
SGZ
HTH 2
HTH 1
Six Mile Well
Jim Bias Well
(Blue Jay Springs)
6
N
Blue Jay
Maint Sta
Scale in Miles
0
5
0
5
10
3 81
Scale in Kilometers
Surface Ground Zero
Water Sampling Locations
Nevada
SGZ
Nye
County
Location Maps

Figure E-9. LTHMP sampling locations for Project Faultless.

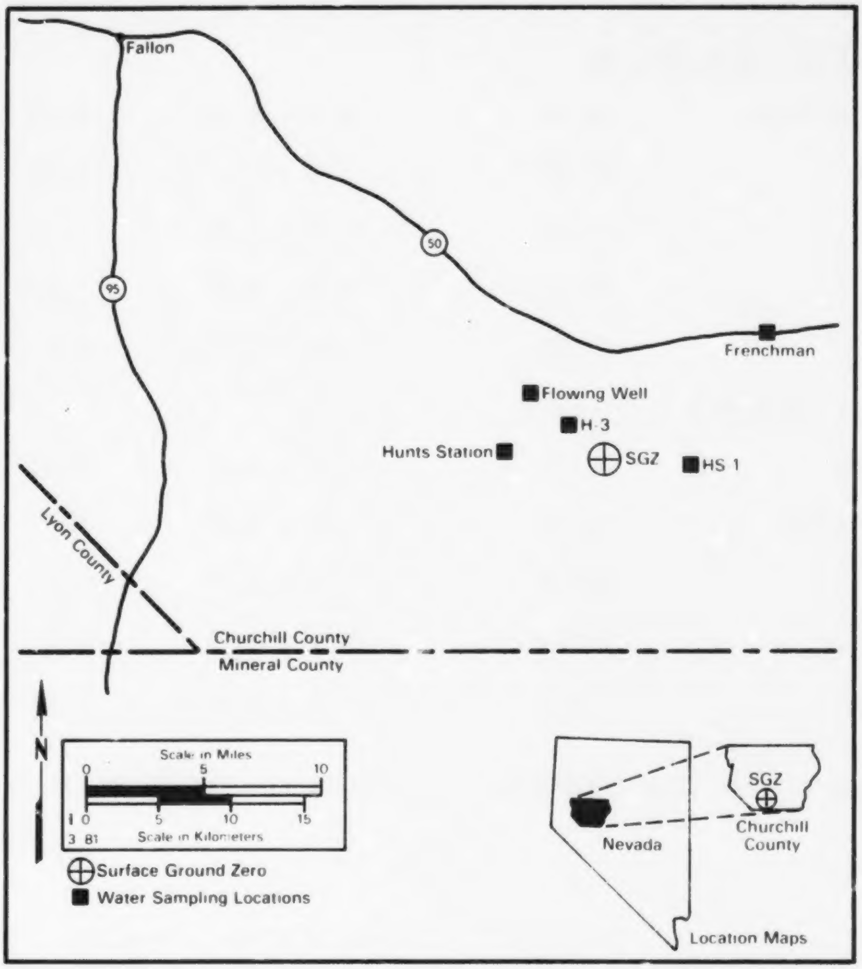
Fallon
50
95
Frenchman
Flowing Well
H-3
Hunts Station
SGZ
HS-1
Lyon County
Churchill County
Mineral County
N
Scale in Miles
0
5
10
0
5
10
15
Scale in Kilometers
3-81
Surface Ground Zero
Water Sampling Locations
SGZ
Churchill County
Nevada
Location Maps

Figure E-10. LTHMP sampling locations for Project Shoal.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT FAULTLESS - BLUE JAY, NV			
MAINTENANCE STATION	07/20	5.5 ± 5.2*	0.03
SIXMILE WELL	07/20	19 ± 5	0.09
WELL HTH-1	07/19	7.3 ± 5.4*	0.04
WELL HTH-2	07/19	6.0 ± 5.3*	0.03
BIAS WELL	07/20	180 ± 7	0.9
PROJECT SHOAL - FRENCHMAN STATION, NV			
HUNTS STATION	02/23	2.2 ± 5.1*	0.01
FRENCHMAN STATION	02/24	1.8 ± 4.9*	<0.01
WELL HS-1	02/24	1.7 ± 5.1*	<0.01
WELL H-3	02/23	-0.72 ± 4.9*	<0.01
FLOWING WELL	02/23	2.1 ± 5.0*	0.01

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

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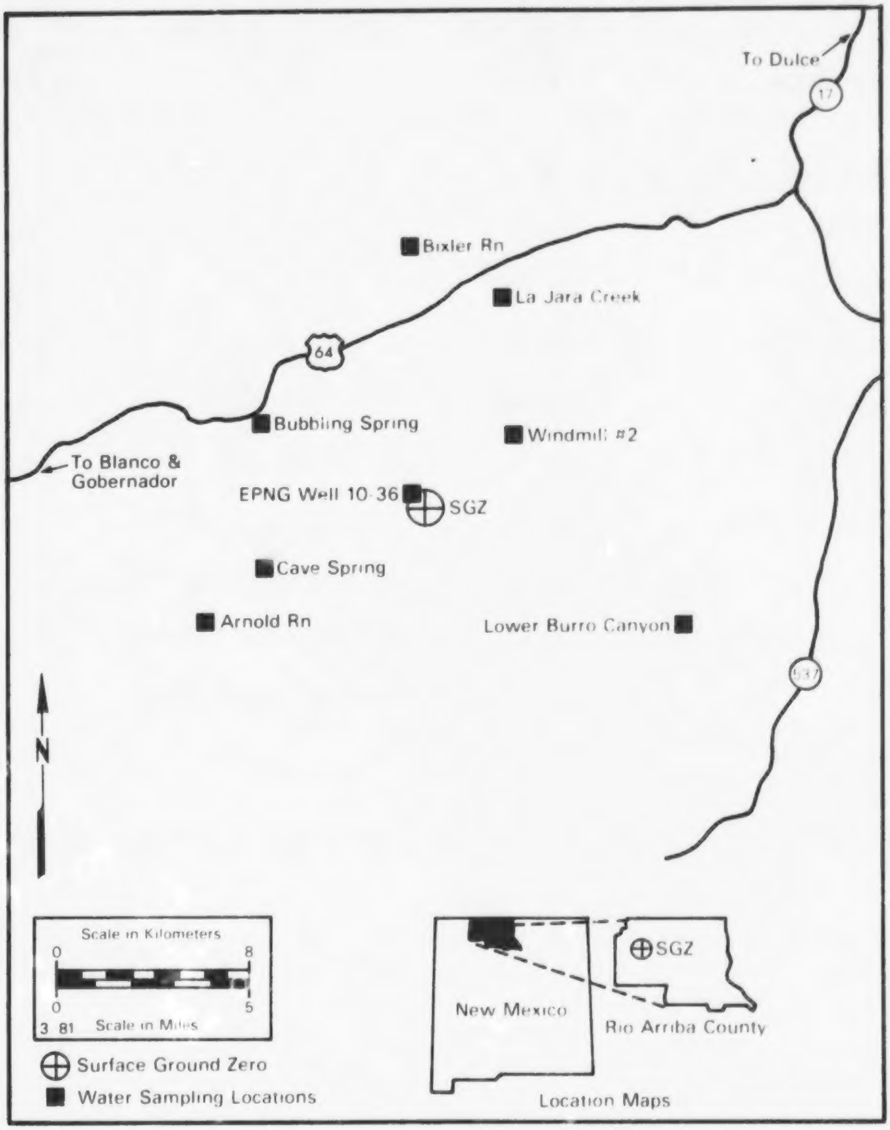
To Dulce
17
Bixler Rn
La Jara Creek
64
Bubbling Spring
Windmill #2
To Blanco & Gobernador
EPNG Well 10-36
SGZ
Cave Spring
Arnold Rn
Lower Burro Canyon
537
N
Scale in Kilometers
0
8
0
5
3 81
Scale in Miles
Surface Ground Zero
Water Sampling Locations
New Mexico
SGZ
Rio Arriba County
Location Maps

Figure E-11. LTHMP sampling locations for Project Gasbuggy.

TABLE E-9. CONTINUED

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT GASBUGGY - GOBERNADOR, NM			
ARNOLD RANCH	06/03	1.1 ± 5.1*	<0.01
BIXLER RANCH	06/03	18 ± 5	0.09
BUBBLING SPRINGS	06/05	110 ± 6	0.5
CAVE SPRINGS	06/05	100 ± 6	0.5
LA JARA CREEK	06/05	100 ± 6	0.5
LOWER BURRO CANYON	06/03	4.6 ± 7.4*	0.02
WELL 28.3.33.233 SOUTH	06/05	NO SAMPLE COLLECTED	
WELL 30.3.32.343 NORTH	06/05	NO SAMPLE COLLECTED	
WINDMILL 2	06/05	NO SAMPLE COLLECTED	
EPNG WELL 10-36	06/04	18 ± 5	0.09

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

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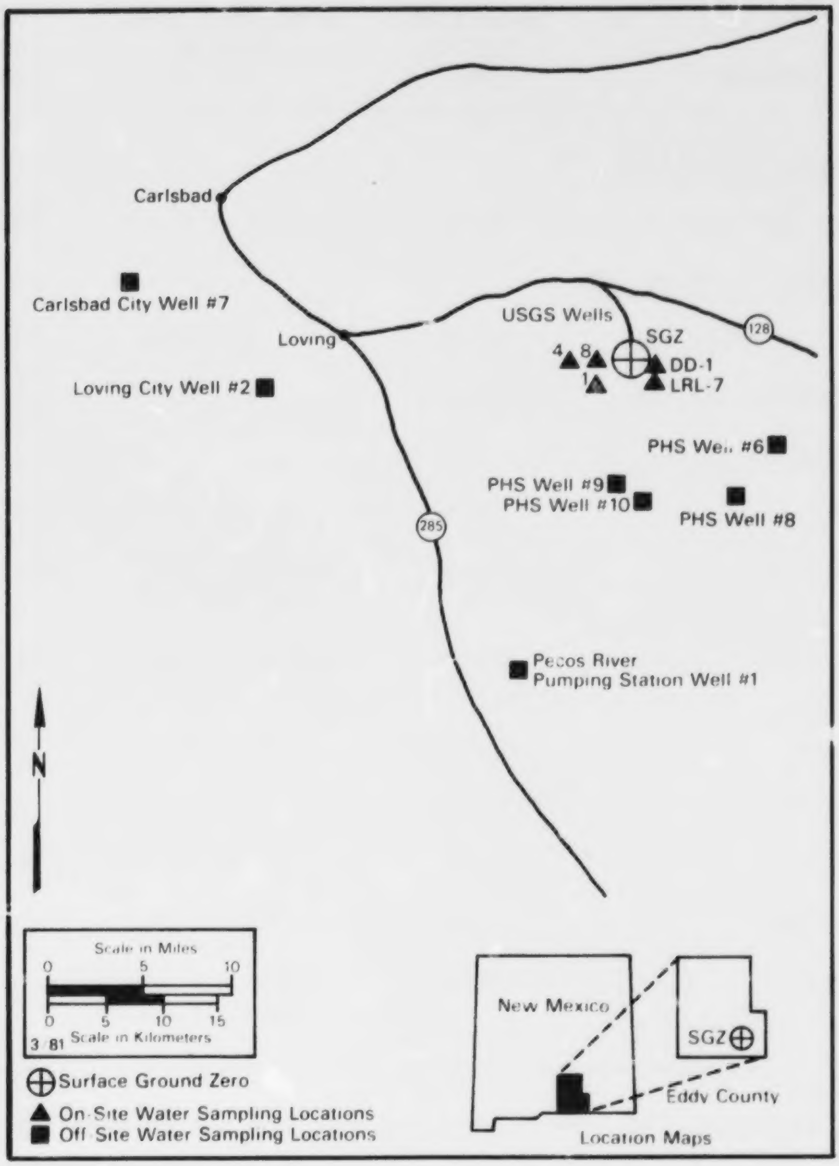
Carlsbad
Carlsbad City Well #7
Loving
Loving City Well #2
USGS Wells
SGZ
4
8
1
DD-1
LRL-7
128
PHS Well #6
PHS Well #9
PHS Well #10
PHS Well #8
285
Pecos River Pumping Station Well #1
N
Scale in Miles
0
5
10
0
5
10
15
Scale in Kilometers
3/81
Surface Ground Zero
On-Site Water Sampling Locations
Off-Site Water Sampling Locations
New Mexico
SGZ
Eddy County
Location Maps

Figure E-12. LTHMP sampling stations for Project Gnome.

TABLE E-9. CONTINUED.

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT GNOME - CARLSBAD, NM			
CARLSBAD CITY WELL 7	03/28	-0.85 ± 5.1*	<0.01
PROJECT GNOME - LOVING, NM			
LOVING CITY WATER WELL	03/28	4.9 ± 4.9*	0.02
PECOS PUMPING STATION	03/26	-0.79 ± 5.0*	<0.01
PROJECT GNOME - MALAGA, NM			
USGS WELL 1	03/29	-2.3 ± 5.1*	<0.01
USGS WELL 4	03/29	330000 ± 4100 (SEE NOTE 1)	2000
USGS WELL 8	03/29	260000 ± 3800 (SEE NOTE 2)	1000
PHS WELL 6	03/27	130 ± 6	0.6
PHS WELL 8	03/28	15 ± 5	0.08
PHS WELL 9	03/28	-1.7 ± 5.1*	<0.01
PHS WELL 10	03/28	-2.2 ± 5.2*	<0.01
WELL LRL-7	03/30	23000 ± 2100 (SEE NOTE 3)	100

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC)

	ANALYSIS	RESULT	2 SIGMA	UNITS
NOTE 1	90Sr	9000	64	pCi/L
	137Cs	10	2	pCi/L
NOTE 2	90Sr	5700	49	pCi/L
	137Cs	61	11	pCi/L
NOTE 3	90Sr	13	2	pCi/L
	137Cs	220	20	pCi/L

TABLE E-10. 1983 SUMMARY OF ANALYTICAL RESULTS FOR THE MILK SURVEILLANCE NETWORK

SAMPLING LOCATION	SAMPLE TYPE	NO. OF SAMPLES	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/L)		
				MAX	MIN	AVG
BISHOP, CA, WHITE MOUNTAIN RANCH	13	1	3H	200	200	200
		1	89SR	-0.60	-0.60	-0.60
		1	90SR	-0.60	-0.60	-0.60
HINKLEY, CA, BILL NELSON DAIRY	12	4	3H	330	-360	-32
		3	89SR	2.8	-1.5	1.1
		4	90SR	1.7	0.053	0.70
RIDGECREST, CA, CEDARSAGE FARM	10	3	3H	63	-160	-79
		3	89SR	5.6	1.7	3.1
		3	90SR	-0.25	-1.0	-0.54
KEOUGH HOT SPGS, CA, YRIBARREN RCH	13	3	3H	150	-160	-53
		2	89SR	4.3	3.4	3.9
		2	90SR	3.4	2.6	3.0
ALAMO, NV, WHIPPLE RANCH	13	3	3H	170	-20	58
		3	89SR	1.0	-4.7	-0.94
		3	90SR	1.4	-0.37	0.23
RACHEL, NV, FALLIS RANCH	10	4	3H	190	-140	24
		4	89SR	0.68	-8.4	-3.1
		4	90SR	3.3	-1.5	1.2
RACHEL, NV, JAMES MOODY	13	2	3H	140	-18	63
		2	89SR	0.41	-0.86	-0.23
		2	90SR	1.0	0.66	0.84
AUSTIN, NV, YOUNG'S RANCH	13	4	3H	220	45	110
		4	89SR	1.5	-2.0	0.31
		4	90SR	1.8	-0.55	0.46
CURRANT, NV, BLUE EAGLE RANCH	13	4	3H	190	-100	-9.9
		4	89SR	1.5	-8.5	-2.4
		4	90SR	5.1	0.38	2.7
CURRANT, NV, MANZONIE RANCH	13	3	3H	190	-140	-0.67
		3	89SR	3.1	-7.5	-1.3
		3	90SR	2.9	-1.0	1.1

CONTINUED

TABLE E-10. (Cont.)

SAMPLING LOCATION	SAMPLE TYPE	NO. OF SAMPLES	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/L) MAX	MIN	AVG
HIKO, NV,	13	1	3H	360	360	360
DARREL HANSEN RANCH		1	89SR	-3.5	-3.5	-3.5
		1	90SR	1.0	1.0	1.0
LAS VEGAS, NV,	12	4	3H	310	-86	39
LDS DAIRY FARMS		4	89SR	2.5	-8.2	-1.1
		4	90SR	1.5	-0.57	0.14
LIDA, NV,	13	3	3H	34	-140	-26
LIDA LIVESTOCK COMPANY		2	89SR	5.0	-0.78	2.1
		3	90SR	1.4	-2.0	-0.31
LOGANDALE, NV,	12	4	3H	230	-170	-1.8
KNUDSEN DAIRY		4	89SR	6.6	-13	-1.7
		4	90SR	4.0	-1.7	0.98
LUND, NV,	12	4	3H	86	-320	-100
MCKENZIE DAIRY		4	89SR	2.1	0.020	0.81
		4	90SR	0.25	-0.41	0.048
MCGILL, NV,	13	3	3H	99	-130	-8.4
LARSEN RANCH		3	89SR	3.0	0.83	1.9
		3	90SR	2.1	-0.22	0.65
MESQUITE, NV,	12	4	3H	300	-320	-42
SF AND K DAIRY		3	89SR	-1.3	-7.7	-3.5
		3	90SR	0.61	-0.72	-0.18
MOAPA, NV,	12	4	3H	210	-170	-32
DECADE CORP		4	89SR	4.8	-1.9	1.6
		4	90SR	1.8	-2.1	-0.074
NYALA, NV,	13	4	3H	210	-5.2	87
SHARP'S RANCH		4	89SR	7.8	-0.92	4.0
		4	90SR	0.76	-2.7	-0.37
CALIENTE, NV,	13	4	3H	190	-37	92
JUNE COX RANCH		4	89SR	0.66	-0.16	0.12
		4	90SR	1.6	-0.63	0.58
ROUND MT, NV,	13	2	3H	-73	-110	-91
BERG'S RANCH		2	89SR	0.35	-3.1	-1.4
		2	90SR	2.0	0.77	1.4

CONTINUED

TABLE E-10. (Cont.)

SAMPLING LOCATION	SAMPLE TYPE	NO. OF SAMPLES	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/L) MAX	MIN	AVG
SHOSHONE, NV, HARBECKE RANCH	13	4	3H	260	-94	110
		4	89SR	4.3	-3.6	0.47
		4	90SR	3.6	0.055	1.5
WARM SPRINGS, NV, TWIN SPRINGS RCH	13	3	3H	88	-89	-1.8
		3	89SR	7.3	1.0	4.1
		3	90SR	2.0	-0.63	0.68
CEDAR CITY, UT, WESTERN GEN DAIRIES	12	4	3H	230	-180	48
		4	89SR	4.1	0.45	2.0
		4	90SR	1.6	-0.49	0.56
ST GEORGE, UT, DROUBAY DAIRY	12	4	3H	170	-24	81
		4	89SR	5.5	-9.3	0.22
		4	90SR	4.3	-2.8	1.5

TABLE E-11. ANALYTICAL RESULTS FOR THE STANDBY MILK SURVEILLANCE NETWORK 1983

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA 3H (PCI/L)	 89SR (PCI/L)	 90SR (PCI/L)
A. GAMMA SPECTRAL AND RADIOCHEMICAL ANALYSES				
TAYLOR ARIZ SUNRISE DAIRY	06/06	35 ± 340*	-8.8 ± 4.9*	1.9 ± 2.8*
TUCSON ARIZ SHAMROCK DAIRY (PIMA CO)	06/06	-27 ± 340*	-0.21 ± 4.1*	0.26 ± 2.3*
LITTLE ROCK ARK BORDENS	0815	150 ± 320*	NA	NA
RUSSELLVILLE ARK ARKANSAS TECH UNIV	08/19	92 ± 320*	NA	NA
BAKERSFIELD CALIF CARNATION DAIRY	07/11	40 ± 340*	-1.7 ± 3.2*	1.3 ± 2.7*
LEMON GROVE CALIF MILLER DAIRY	07/11	NA	2.7 ± 4.2*	-0.21 ± 2.5*
WEED CALIF MEDO-BEL CREAMERY	07/12	NA	1.7 ± 2.0*	-0.35 ± 2.0*
WILLOWS CALIF FOREMOST FOODS COMPANY	07/12	-210 ± 340*	2.5 ± 4.1*	0.29 ± 2.7*
GRAND JCT COLO COLORADO WEST DAIRIES	07/25	-200 ± 340*	NA (LOST)	-0.57 ± 2.0*
PUEBLO COLO HYDE PARK DAIRY CO	07/27	190 ± 340*	2.7 ± 2.3*	0.14 ± 1.9*
IDAHO FALLS IDA WESTERN GENERAL DAIRY	08/15	98 ± 340*	NA	NA
BURLINGTON IOWA MISS VALLEY MILK PRO	06/06	-71 ± 340*	-4.2 ± 3.6*	4.6 ± 3.2
DAVENPORT IOWA SWISS VALLEY FARMS CO	06/04	-130 ± 34*	NA 89SR LOST	1.9 ± 1.9*

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

CONTINUED

TABLE E-11. (Cont.)

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA		
		3H (PCI/L)	89SR (PCI/L)	90SR (PCI/L)
LEMARS IOWA WELLS DAIRY	06/06	NA	1.4 ± 3.0*	2.0 ± 2.4*
CONCORDIA KAN FAIRMONT FOOD CO	06/23	22 ± 340*	-4.0 ± 3.6*	3.2 ± 2.7
GARDEN CITY KAN MYERS MILK PROD	06/04	170 ± 340	-7.3 ± 3.8*	2.0 ± 2.3*
MONROE LA BORDEN'S	06/28	NA	16 ± 11*	0.67 ± 5.4*
NEW ORLEANS LA BORDEN'S	08/09	67 ± 340*	4.3 ± 4.4*	2.7 ± 3.5*
ROCHESTER MINN ASSC MILK PRODUCERS	08/23	160 ± 320*	0.12 ± 3.4*	0.64 ± 3.4*
AURORA MO MID-AMERICA DAIRY INC	06/05	120 ± 340*	-1.3 ± 3.2*	5.3 ± 2.8
CHILLICOTHE MO MID-AMERICA DAIRYMEN	06/06	-140 ± 340*	-0.92 ± 3.3*	4.2 ± 2.9
NORFOLK NEB GILLETTE DAIRY	07/05	140 ± 300*	0.88 ± 3.8*	0.17 ± 3.3*
NORTH PLATTE NEB MID AMERICA DAIRYMEN	06/06	170 ± 340*	-13 ± 5*	6.1 ± 3.8
FALLON NEV CREAMLAND DAIRY	07/11	-170 ± 340*	2.8 ± 3.9*	0.037 ± 2.3*
LAS VEGAS NEV ANDERSON DAIRY	07/12	NA	0.76 ± 2.4*	0.57 ± 2.2*
BISMARCK N DAK BRIDGEMENS CREAMERY	07/26	67 ± 340*	0.15 ± 1.5*	2.6 ± 2.5
GRAND FORKS N DAK MINNESOTA DAIRY	07/25	190 ± 310*	NA (LOST)	0.45 ± 2.5*

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).

CONTINUED

TABLE E-11. (Cont.)

SAMPLING LOCATION	COLLECTION DATE 1983	CONC. ± 2 SIGMA 3H (PCI/L)	89SR (PCI/L)	90SR (PCI/L)
ENID OKLA AMPI GOLDSPOT DIVISION	07/22	-80 ± 340*	-4.0 ± 1.7*	4.6 ± 2.5
MCALESTER OKLA OKLA ST PENITENTIARY	06/23	100 ± 300*	1.0 ± 3.0*	2.1 ± 2.2*
CORVALLIS ORE SUNNY BROOK DAIRY	08/16	-24 ± 320*	NA	NA
MEDFORD ORE DAIRYGOLD FARMS	08/15	130 ± 320*	0.77 ± 1.6*	1.6 ± 1.8*
SIOUX FALLS S DAK TERRACE PARK DAIRY	07/25	-130 ± 340*	NA (LOST)	1.8 ± 2.3*
PROVO UTAH BYU DAIRY PRODUCTS LAB	07/25	170 ± 310*	-2.1 ± 2.1*	2.5 ± 2.4*
SEATTLE WASH CONSOLIDATED DAIRY PROD	08/16	160 ± 320*	0.90 ± 2.1*	0.95 ± 2.3*
SPOKANE WASH CONSOLIDATED DAIRY	08/14	160 ± 320*	-2.8 ± 5.3*	1.3 ± 4.5*

B. GAMMA SPECTRAL ANALYSES ONLY**

SAMPLING LOCATION	COLLECTION DATE 1983	SAMPLING LOCATION	COLLECTION DATE 1983
PIMA ARIZ SMITH HUNT DAIRY	06/06	KINGMAN ARIZ CANYON FARMS	06/06
TEMPE ARIZ UNITED DAIRYMEN OF AZ	06/06	YUMA ARIZ GOLDEN WEST DAIRY	06/06
FAYETTEVILLE ARK UNIVERSITY OF ARK	08/15	PARAGOULD ARK FOREMOST FOODS INC	08/17

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* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).
**POTASSIUM-40 WAS THE ONLY GAMMA-EMITTER DETECTED IN THESE SAMPLES.

CONTINUED

TABLE E-11. (Cont.)

SAMPLING LOCATION	COLLECTION DATE 1983
HELENDALE CALIF OSTERKAMP DAIRY NO 2	07/13
FERNBRIDGE CALIF HUMBOLDT CREAMERY	07/11
MANTECA CALIF DEJAGER DAIRY Δ2 NORTH	07/11
OXNARD CALIF CHASE BROS DAIRY	07/13
PALO ALTO CALIF PENINSULA CREAMERY	07/12
REDDING CALIF MCCOLL'S DAIRY PROD	07/11
SAN LUIS OBISPO CALIF CAL STATE POLY	07/11
SANTA ROSA CALIF GLEN OAKS FARM	07/11
SAUGUS CALIF WAYSIDE HONOR RANCH	07/13
SMITH RIVER CALIF COUNTRY MAID DAIRY	07/11
TRACY CALIF DEUEL VOC INST	07/12
FT COLLINS COLO POUDRE VALLEY DAIRY	07/25
KIMBALLTON IOWA AMPI RECEIVING STA	06/06
LAKE MILLS IOWA LAKE MILLS COOP CRMY	06/06
CHINO CALIF CALIF INST FOR MEN	08/16
FRESNO CALIF STATE UNIV CREAMERY	07/11
MODESTO CALIF FOSTER FARMS DAIRY	07/11
DALTON MINN DALTON CO-OP CREAMERY	08/22
FLENSBURG MINN FLENSBURG CO-OP CMRY	08/22
NICOLLET MINN WALTER SCHULTZ FARM	08/22
JACKSON MO MID-AMERICA DAIRYMEN IN	06/06
JEFFERSON CITY MO CENTRAL DAIRY CO	06/03
ALBUQUERQUE NM BORDEN'S VALLEY GOLD	07/05
MEADOW GOLD DAIRY	07/25
BOZEMAN MONT DARIGOLD FARMS	07/27
LA PLATA NM ROTHLISBERGER DAIRY	07/05
GREAT FALLS MONT MEADOW GOLD DAIRY	07/27
LAS CRUCES NM LONG'S DAIRY	07/06
EQUITY SUPPLY CO	07/25

CONTINUED

TABLE E-11. (Cont.)

SAMPLING LOCATION	COLLECTION DATE 1983	SAMPLING LOCATION	COLLECTION DATE 1983
ELLIS KAN MID-AMERICA DAIRY	06/04	MISSOULA MONT MEADOW GOLD DAIRY	07/25
HAMMOND LA SOUTHEASTERN LA COLLEGE	06/25	RENO NEV MODEL DAIRY	07/11
LAFAYETTE LA UNIV SOUTHWESTERN LA	06/27	STILLWATER OKLA OSU DAIRY	07/25
RUSTON LA TECH UNIV DAIRY	06/27	MITCHELL S DAK CULHANES DAIRY	07/25
DEVILS LAKE N DAK LAKE VIEW DAIRY	07/25	VOLGA S DAK LAND O'LAKES INC	07/26
FARGO N DAK CASSCLAY CREAMERY	07/26	BEAVER UTAH CACHE VALLEY DAIRY	07/25
WILLISTON N DAK PETERSONS CREAMERY	07/25	CEDAR CITY UTAH WESTERN GEN DAIRIES	07/26
CLAREMORE OKLA SWAN BROS DAIRY	06/22	SMITHFIELD UTAH CACHE VALLEY DAIRY	07/26

TABLE E-12. 1983 SUMMARY OF RADIATION DOSE EQUIVALENTS FROM TLD DATA

STATION LOCATION	MEASUREMENT PERIOD		DOSE EQUIVALENT RATE (MREM/D)			ANNUAL ADJUSTED DOSE EQUIVALENT (MREM/Y)
	ISSUE	COLLECT	MAX.	MIN.	AVG.	
ADAVEN, NV	01/12/83	01/06/84	0.35	0.30	0.32	117
ALAMO, NV	01/13/83	01/06/84	0.25	0.23	0.24	86
AMERICAN BORATE, NV	01/10/83	01/04/84	0.26	0.26	0.26	94
AUSTIN, NV	01/11/83	01/05/84	0.34	0.31	0.33	121
BAKER, CA	01/10/83	01/03/84	0.24	0.22	0.23	83
BARSTOW, CA	01/10/83	01/03/84	0.29	0.28	0.29	105
BEATTY, NV	01/12/83	01/04/84	0.29	0.29	0.29	106
BISHOP, CA	01/12/83	01/04/84	0.27	0.25	0.26	96
BLUE EAGLE RANCH, NV	01/11/83	01/05/84	0.19	0.17	0.18	65
BLUE JAY, NV	01/12/83	01/05/84	0.33	0.30	0.32	116
CACTUS SPRINGS, NV	01/10/83	01/03/84	0.15	0.15	0.15	55
CALIENTE, NV	01/12/83	01/09/84	0.29	0.28	0.29	104
CARP, NV	01/13/83	01/09/84	0.29	0.27	0.28	102
CASEY'S RANCH, NV	01/12/83	01/04/84	0.20	0.19	0.19	70
CEDAR CITY, UT	01/11/83	01/05/84	0.21	0.18	0.19	68
CLARK STATION, NV	01/11/83	01/05/84	0.31	0.30	0.30	110
COALDALE, NV	07/19/83	01/04/84	0.28	0.22	0.25	91
COMPLEX 1, NV	01/12/83	01/06/84	0.32	0.28	0.30	110
CORN CREEK, NV	01/10/83	01/03/84	0.13	0.12	0.12	45
COYOTE SUMMIT, NV	01/11/83	01/03/84	0.33	0.32	0.32	117
CRYSTAL, NV	07/05/83	01/04/84	0.19	0.19	0.19	68

(CONTINUED)

TABLE E-12. CONTINUED

STATION LOCATION	MEASUREMENT PERIOD ISSUE	COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	ANNUAL ADJUSTED DOSE EQUIVALENT (MREM/Y)
CURRANT, NV	01/11/83	01/03/84	0.29	0.27	0.28	101
DEATH VALLEY JCT, CA	01/13/83	01/06/84	0.20	0.19	0.20	72
DIABLO MAINT. STA.	01/11/83	01/04/84	0.34	0.32	0.33	121
DUCKWATER, NV	01/11/83	01/03/84	0.27	0.26	0.26	95
ELGIN, NV	01/13/83	01/09/84	0.32	0.32	0.32	117
ELY, NV	01/13/83	01/04/84	0.22	0.21	0.22	78
ENTERPRISE, UT	01/12/83	01/05/84	0.28	0.26	0.27	99
EUREKA, NV	01/11/83	01/05/84	0.30	0.27	0.29	105
FURNACE CREEK, CA	01/13/83	01/06/84	0.19	0.17	0.18	65
GABBS, NV	07/19/83	01/04/84	0.21	0.15	0.18	66
GARRISON, UT	01/11/83	01/04/84	0.20	0.18	0.19	69
GEYSER RANCH, NV	01/10/83	01/04/84	0.29	0.27	0.28	101
GOLDFIELD, NV	01/10/83	01/03/84	0.25	0.22	0.24	87
GROOM LAKE-NTS, NV	01/10/83	01/03/84	0.21	0.18	0.19	70
HANCOCK SUMMIT,NV	01/10/83	01/03/84	0.41	0.37	0.38	140
HIKO, NV	01/13/83	01/10/84	0.21	0.19	0.20	71
HOT CK RNCH, NV	01/12/83	01/05/84	0.25	0.24	0.24	88
INDEPENDENCE, CA	01/12/83	01/04/84	0.25	0.23	0.24	88
INDIAN SPRINGS, NV	01/10/83	01/03/84	0.14	0.13	0.13	49
KIRKEBY RANCH, NV	01/10/83	01/04/84	0.21	0.19	0.20	73
KOYNES, NV	01/11/83	01/04/84	0.25	0.24	0.24	88

(CONTINUED)

TABLE E-12. CONTINUED

STATION LOCATION	MEASUREMENT PERIOD ISSUE	MEASUREMENT PERIOD COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	DOSE EQUIVALENT RATE (MREM/D) MIN.	DOSE EQUIVALENT RATE (MREM/D) AVG.	ANNUAL ADJUSTED DOSE EQUIVALENT (MREM/Y)
LAS VEGAS (AIRPORT)	12/29/82	01/03/84	0.14	0.14	0.14	51
LAS VEGAS (PLACAK)	12/29/82	01/03/84	0.14	0.14	0.14	51
LAS VEGAS (UNLV) NV	12/29/82	01/03/84	0.12	0.11	0.12	42
LAS VEGAS (USDI)	12/29/82	01/03/84	0.17	0.16	0.17	60
LATHROP WELLS, NV	01/10/83	01/03/84	0.24	0.23	0.24	87
LAVADA'S MARKET NV	01/12/83	01/04/84	0.24	0.21	0.22	81
LIDA, NV	01/10/83	01/03/84	0.27	0.25	0.26	93
LONE PINE, CA	01/12/83	01/04/84	0.25	0.24	0.24	88
LUND, NV	01/13/83	01/03/84	0.23	0.22	0.22	81
MAMMOTH MOUNTAIN, CA	01/12/83	01/05/84	0.34	0.22	0.27	97
MANHATTAN, NV	01/11/83	01/05/84	0.33	0.24	0.30	110
MESQUITE, NV	01/10/83	01/04/84	0.17	0.16	0.16	60
MINA, NV	07/19/83	01/04/84	0.26	0.21	0.24	86
MOAPA, NV	01/10/83	01/03/84	0.18	0.17	0.18	64
NYALA, NV	01/12/83	01/04/84	0.22	0.22	0.22	79
OLANCHA,CA.	01/12/83	01/04/84	0.25	0.25	0.25	91
OVERTON, NV	01/10/83	01/04/84	0.16	0.15	0.15	55
PAHRUMP, NV	01/13/83	01/04/84	0.14	0.13	0.13	49
PENOYER FARMS, NV	01/11/83	01/04/84	0.31	0.30	0.30	109
PINE CK RNCH, NV	01/12/83	01/06/84	0.33	0.31	0.32	117
PIOCHE, NV	01/12/83	01/09/84	0.22	0.20	0.21	77

(CONTINUED)

TABLE E-12. CONTINUED

STATION LOCATION	MEASUREMENT PERIOD ISSUE	MEASUREMENT PERIOD COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	DOSE EQUIVALENT RATE (MREM/D) MIN.	DOSE EQUIVALENT RATE (MREM/D) AVG.	ANNUAL ADJUSTED DOSE EQUIVALENT (MREM/Y)
QUEEN CITY SMT. NV	01/10/83	01/04/84	0.36	0.33	0.34	125
RACHEL, NV	01/11/83	01/04/84	0.29	0.28	0.29	105
REED RANCH, NV	01/11/83	01/04/84	0.30	0.27	0.29	104
RIDGECREST, CA	01/11/83	01/04/84	0.24	0.22	0.23	84
ROUND MT, NV	01/11/83	01/05/84	0.30	0.20	0.28	100
S. DESERT COR. CENTR	07/05/83	01/03/84	0.13	0.13	0.13	46
SALT LAKE CITY, UT	01/17/83	01/23/84	0.22	0.21	0.22	78
SCOTTY'S JCT, NV	01/10/83	01/03/84	0.29	0.26	0.27	99
SHERI'S RANCH, NV	01/14/83	01/10/84	0.22	0.19	0.20	72
SHOSHONE, CA	01/13/83	01/06/84	0.21	0.20	0.20	73
SPRING MEADOWS, NV	01/10/83	04/05/83	0.15	0.15	0.15	56
SPRINGDALE, NV	01/11/83	01/03/84	0.30	0.28	0.29	105
ST. GEORGE, UT	01/11/83	01/04/84	0.15	0.14	0.15	53
STONE CABIN RNCH, NV	01/12/83	01/05/84	0.32	0.30	0.31	112
SUNNYSIDE, NV	01/13/83	01/03/84	0.17	0.15	0.16	57
TEMPIUTE, NV	01/11/83	01/03/84	0.30	0.29	0.30	107
TIKABOO VALLEY, NV	01/10/83	01/03/84	0.29	0.28	0.29	104
TONOPAH TEST RNG, NV	01/11/83	01/04/84	0.28	0.25	0.27	98
TONOPAH, NV	01/11/83	01/04/84	0.32	0.30	0.31	112
TWIN SPRGS RNCH, NV	01/11/83	01/04/84	0.30	0.29	0.29	107
USECOLOGY	01/11/83	01/03/84	0.30	0.28	0.29	104

(CONTINUED)

TABLE E-12. CONTINUED

STATION LOCATION	MEASUREMENT PERIOD ISSUE	COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	ANNUAL ADJUSTED DOSE EQUIVALENT (MREM/Y)
VALLEY CREST, CA	01/13/83	01/06/84	0.16	0.15	0.15	55
WARM SPRINGS, NV	01/12/83	01/05/84	0.33	0.30	0.32	115
YOUNG'S RANCH, NV	01/11/83	01/05/84	0.25	0.25	0.25	91

TABLE E-13. 1983 SUMMARY OF RADIATION DOSES FOR OFFSITE RESIDENTS

RES-I-DENT NO.	BACKGROUND STATION LOCATION	MEASUREMENT PERIOD		DOSE EQUIVALENT RATE (MREM/D)			NET EXPOSURE (MREM)
		ISSUE	COLLECT	MAX.	MIN.	AVG.	
2	Caliente, NV	01/12/83	01/09/84	0.29	0.22	0.25	0.0
3	Blue Jay, NV	01/12/83	01/05/84	0.40	0.24	0.35	20
6	Indian Springs, NV	01/10/83	01/03/84	0.15	0.13	0.14	0.0
7	Goldfield, NV	01/10/83	01/03/84	0.21	0.19	0.20	0.0
8	Twin Springs Ranch, NV	01/11/83	01/04/84	0.27	0.26	0.27	0.0
9	Blue Eagle Ranch, NV	01/11/83	01/09/84	0.17	0.16	0.17	0.0
10	Complex I, NV	01/12/83	01/06/84	0.29	0.26	0.28	0.0
11	Complex I, NV	01/12/83	01/06/84	0.28	0.25	0.27	0.0
12	Corn Creek, NV	12/29/82	10/03/83	0.12	0.11	0.11	0.0
13	Koynes Ranch, NV	01/11/83	01/04/84	0.18	0.17	0.18	0.0
14	Hancock Summit, NV	01/10/83	01/19/84	0.27	0.24	0.25	0.0
15	Hancock Summit, NV	01/10/83	01/19/84	0.26	0.22	0.24	0.0
17	Nyala, NV	01/12/83	07/06/83	0.19	0.18	0.19	0.0
18	Nyala, NV	01/12/83	01/04/84	0.20	0.18	0.19	0.0
19	Goldfield, NV	01/10/83	01/08/84	0.24	0.20	0.21	0.0
21	Beatty, NV	01/11/83	01/04/84	0.24	0.21	0.23	0.0
22	Alamo, NV	01/13/83	01/06/84	0.19	0.16	0.17	0.0
24	Corn Creek, NV	12/29/82	01/03/84	0.13	0.11	0.12	0.0
25	Corn Creek, NV	12/29/82	01/03/84	0.14	0.14	0.14	0.0
27	Pahrump, NV	01/13/83	01/04/84	0.17	0.16	0.17	9.1

(CONTINUED)

TABLE E-13. CONTINUED

RES-I-DENT NO.	BACKGROUND STATION LOCATION	MEASUREMENT PERIOD		DOSE EQUIVALENT RATE (MREM/D)			NET EXPOSURE (MREM)
		ISSUE	COLLECT	MAX.	MIN.	AVG.	
28	Hot Creek Ranch, NV	01/12/83	01/05/84	0.28	0.23	0.25	4.0
29	Stone Cabin Ranch, NV	01/12/83	01/05/84	0.27	0.24	0.26	0.0
30	Rachel, NV	01/11/83	01/03/84	0.24	0.23	0.24	0.0
33	Lathrop Wells, NV	04/05/83	01/04/84	0.25	0.19	0.22	0.0
34	Furnace Creek, CA	01/13/83	01/06/84	0.16	0.08	0.13	0.0
35	Death Valley Jct., CA	01/13/83	01/06/84	0.19	0.18	0.18	0.0
36	Pahrump, NV	01/13/83	01/04/84	0.13	0.12	0.13	0.0
37	Indian Springs, NV	01/10/83	01/03/84	0.23	0.13	0.16	8.9
38	Beatty, NV	01/13/83	01/04/84	0.38	0.24	0.29	7.7
40	Goldfield, NV	01/10/83	10/03/83	0.22	0.20	0.21	0.0
41	Austin, NV	01/11/83	01/05/84	0.35	0.27	0.31	0.0
42	Tonopah, NV	01/11/83	01/04/84	0.27	0.25	0.26	0.0
43	Alamo, NV	01/13/83	04/08/83	0.20	0.20	0.20	0.0
44	Cedar City, UT	01/11/83	01/05/84	0.25	0.19	0.21	6.5
45	St. George, UT	01/11/83	01/19/84	0.20	0.15	0.17	6.8
47	Ely, NV	01/11/83	01/05/84	0.19	0.16	0.18	0.0
48	Rachel, NV	01/11/83	01/04/84	0.22	0.21	0.22	0.0
49	Las Vegas, UNLV	12/29/82	01/03/84	0.25	0.20	0.23	45
50	Hot Creek Ranch, NV	01/12/83	01/05/84	0.27	0.25	0.26	2.2
51	Tonopah, NV	04/06/83	01/04/84	0.23	0.23	0.23	0.0

(CONTINUED)

TABLE E-13. CONTINUED

RES-I-DENT NO.	BACKGROUND STATION LOCATION	MEASUREMENT PERIOD ISSUE	MEASUREMENT PERIOD COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	NET EXPOSURE (MREM)
52	Salt Lake City, UT	01/17/83	02/06/84	0.33	0.24	0.29	20
53	Shoshone, CA	01/13/83	10/14/83	0.20	0.16	0.18	0.0
54	Rachel, NV	01/11/83	01/04/84	0.28	0.26	0.27	0.0
55	Rachel, NV	01/11/83	01/04/84	0.28	0.25	0.27	0.0
56	Corn Creek Station NV	12/29/82	01/03/84	0.17	0.16	0.16	9.9
57	Overton, NV	01/10/83	01/19/84	0.22	0.20	0.21	21
58	Alamo, NV	07/01/83	01/06/84	0.19	0.18	0.19	0.0
59	Cedar City, UT	08/05/83	01/05/84	0.20	0.18	0.19	0.0
60	Shoshone, CA	10/14/83	01/18/84	0.19	0.19	0.19	0.0

ACKNOWLEDGEMENT

Jaci L. Hopper, a health physicist for the Reynolds Electrical and Engineering Co., performs the calibration and readout of the TLD's used in the Dosimetry Network as described in Section 5 of this report. These services plus a summary of the results and preliminary interpretation are supplied, under contract, to the Nuclear Radiation Assessment Division, EMSL-LV.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. DOE/DP/0539-051 May 1984	2.	3. RECIPIENT'S ACCESSION NO.

4. TITLE AND SUBTITLE OFFSITE ENVIRONMENTAL MONITORING REPORT Radiation Monitoring Around U.S. Nuclear Test Areas, Calendar Year 1983	5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. G. Patzer, S. C. Black, R. F. Grossman, and D. D. Smith	8. PERFORMING ORGANIZATION REPORT NO. EPA-600/4-84-040
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring Systems Laboratory Office of Research and Development U.S. Environmental Protection Agency Las Vegas, Nevada 89114	10. PROGRAM ELEMENT NO. X6EH10 11. CONTRACT/GRANT NO. IAG DE-A108-76DP00539
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Energy Nevada Operations Office P.O. Box 14100 Las Vegas, NV 89114	13. TYPE OF REPORT AND PERIOD COVERED Response - 1983 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared for the U.S. Department of Energy under Interagency Agreement No. DE-A108-76DP00539

16. ABSTRACT

This report covers the routine radiation monitoring activities conducted by the Environmental Monitoring Systems Laboratory-Las Vegas in areas which may be affected by nuclear testing programs of the Department of Energy. This monitoring is conducted to document compliance with standards, to identify trends in environmental radiation, and to provide such information to the public. It summarizes these activities for calendar year 1983.

No radioactivity attributable to NTS activities was detectable offsite by the monitoring networks. Using recorded wind data and Pasquill stability categories, atmospheric dispersion calculations based on reported radionuclide releases yeild an estimated dose of 5X10^{-5} man-rem to the population within 80 km of the Nevada Test Site during 1983. World-wide fallout of Kr-85, Sr-90, Cs-137, and Pu-239 detected by the monitoring networks would cause maximum exposure to an individual of less than 0.2 mrem per year. Plutonium and krypton in air were similar to 1982 levels while cesium and strontium in other samples were near the detection limits. An occasional net exposure to offsite residents has been detected by the TLD network. On investigation, the cause of such net exposures has been due to personal habits or occupational activities, not to NTS activities.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT RELEASE TO THE PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 141
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

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